HEWLETT-PACKARD

16

606A

HIGH FREQUENCY SIGNAL GENERATOR

SERIALS PREFIXED: 009-

OPERATING AND SERVICING MANUAL

16

PRINTED 3/10

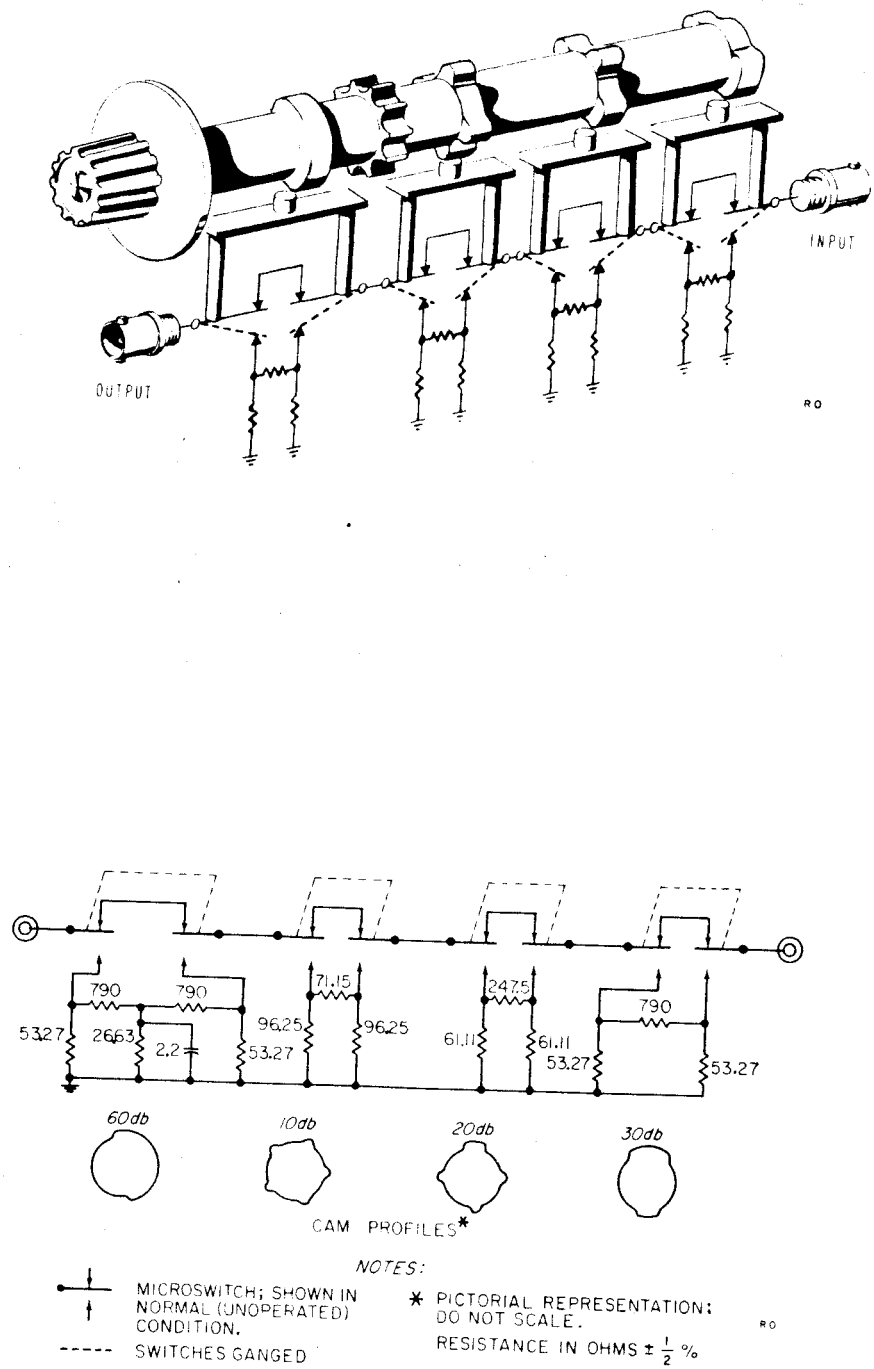

Figure 4-11. Model 606A Output Attenuator

OPERATING AND SERVICING MANUAL

MODEL 606A
HIGH FREQUENCY
SIGNAL GENERATOR

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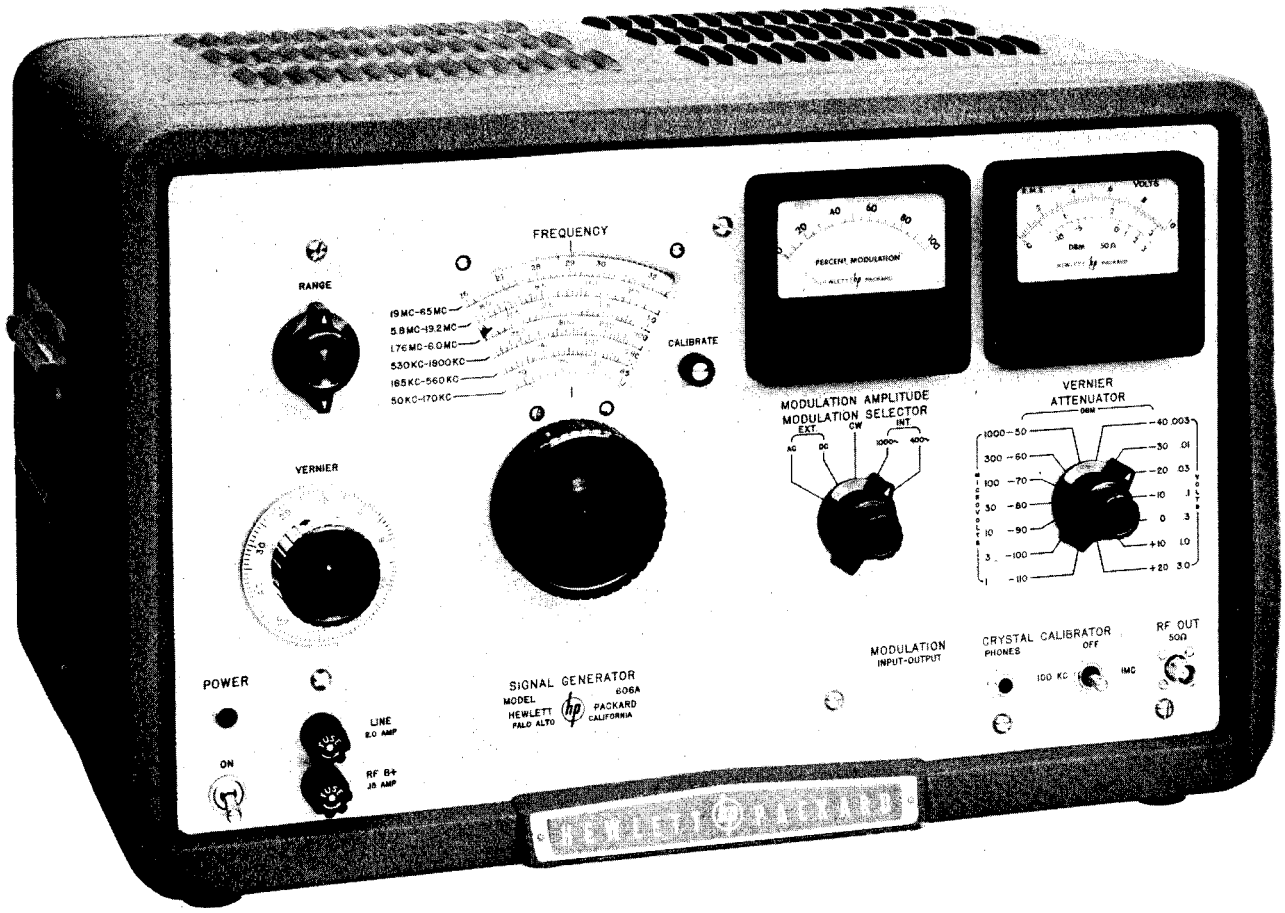

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SPECIFICATIONS

FREQUENCY RANGE:	50 kc to 65 mc in 6 bands.

50 - 170 kc	1.76 - 6.0 mc
165 - 560 kc	5.8 - 19.2 mc
530 - 1800 kc	19.0 - 65.0 mc

FREQUENCY ACCURACY:	Within ±1%.
FREQUENCY CALIBRATOR:	Crystal oscillator provides check points at 100 kc (useful to 6 mc) and 1 mc intervals, accurate within 0.01% from 0° to 50° C.
RF OUTPUT LEVEL:	Continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. Calibration is in volts and dbm (0 dbm is 1 milliwatt).
OUTPUT ACCURACY:	Within ±1 db into 50 ohm resistive load.
FREQUENCY RESPONSE:	Within ±1 db into 50 ohm resistive load over entire frequency range at any output level setting.
OUTPUT IMPEDANCE:	50 ohms, swr less than 1.1 on 0.3 volt range; on 1 volt and 3 volt ranges, less than 1.1 to 20 mc and less than 1.2 to 65 mc. BNC output connector mates with UG-88A/B/C/D.
SPURIOUS HARMONIC OUTPUT:	Less than 3%.
LEAKAGE:	Negligible; permits receiver sensitivity measurements down to at least 0.1 microvolt.
AMPLITUDE MODULATION:	Continuously adjustable from 0 to 100%. Indicated by a panel meter. Modulation level is constant within ±1/2 db regardless of carrier frequency and output level changes.
INTERNAL MODULATION:	0 to 100% sinusoidal modulation at 400 cps ±5% or 1000 cps ±5%.

SPECIFICATIONS (CONT'D.)

MODULATION BANDWIDTH: DC to 20 kc maximum, depends on carrier frequency, f_c, and percent modulation as shown in the following table:

Max. Mod. Frequency	30% Mod.	70% Mod.	Square Wave Mod.
	$0.06\ f_c$	$0.02\ f_c$	$0.003\ f_c$ (3 kc max)

EXTERNAL MODULATION: 0 to 100% sinusoidal modulation dc to 20 kc. 4.5 volts peak produces 100% modulation at modulating frequencies from dc to 20 kc. Input impedance is approximately 600 ohms. May also be modulated by square waves and other complex signals.

ENVELOPE DISTORTION: At output levels of 1 volt or less; less than 1% at 30% modulation using internal 400/1000 cps source, less than 3% from 0 to 70% modulation.

MODULATION METER ACCURACY: Within ±5% from 0 to 90%.

INCIDENTAL FM: At 1 volt or less output and 30% amplitude modulation: 0.0025% or 100 cps, whichever is greater.

SPURIOUS FM: Less than 0.0001% or ±20 cps whichever is greater.

SPURIOUS AM: Hum and noise sidebands are 70 db below carrier down to thermal level of 50 ohm output system.

FREQUENCY DRIFT: Less than 0.005% or 5 cps whichever is greater, for a 10 minute period after warm-up.

POWER: 115/230 volts ±10%, 50 to 1000 cps, 135 watts.

SIZE: Cabinet Mount: 20-1/2 in. wide, 12-1/2 in. high, 14-3/4 in. deep.
Rack Mount: 19 in. wide, 10-1/2 in. high, 13-1/2 in. deep behind panel.

WEIGHT: Cabinet Mount: Net 46 lbs., shipping 66 lbs.
Rack Mount: Net 43 lbs., shipping 65 lbs.

ACCESSORIES AVAILABLE: 606A-34A Output Termination. Three positions: 50 ohms, for use into high impedance; 5 ohms (10:1 voltage division); IRE Standard Dummy Antenna (driven from 10:1 divider).

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SECTION I
GENERAL INFORMATION

1-1 GENERAL DESCRIPTION

The Hewlett-Packard Model 606A is a general-purpose signal generator with a frequency range of 50 kc to 65 mc in six ranges. The instrument has a direct reading frequency dial calibrated to an accuracy of 1%.

Output is held constant within ±1 db and is continuously adjustable from 0.1 μv to 3 volts into a 50 ohm resistive load. In addition, a termination with a 10:1 voltage divider which lowers the minimum output to 0.01 μv (from a 5 ohm source) or a dummy antenna which simulates the standard IRE standard dummy antenna for precision measurements on receivers is available. An internal crystal calibrator provides check points at 100 kc and 1 mc intervals with an error of less than 0.01%. A front panel meter accurately indicates the percent amplitude modulation for frequencies within the modulation bandwidth of the signal generator.

The instrument has a highly refined modulation system which allows modulation up to 90% with low distortion and incidental fm. This feature makes possible precision distortion checks of receivers from antennas to output. The instrument has built-in 400 and 1000 cps modulation and can accept external modulation from 20 cps to 20 kc or more, depending on rf frequency in use.

1-2 OUTPUT TERMINATION

This signal generator is designed to be used with an ℗ 606A-34A Output Termination. THE OUTPUT LEVEL IS CALIBRATED ONLY WHEN USED WITH THIS TERMINATION OR A 50 OHM RESISTIVE LOAD. Further details concerning the use of this output termination will be found in Section II.

1-3 INITIAL INSPECTION

Your instrument was individually tested and inspected before leaving the factory and met all specifications as printed at the front of this manual. Upon receipt, you should inspect and operate the instrument to verify proper operation. If any damage is found, refer to the "Claim for Damage in Shipment" page of this manual.

The only preliminary check necessary before turn-on is to check the meter movement mechanical zero. The meter pointer should rest directly over zero when the instrument is turned off. Best accuracy is obtained if you observe this with one eye only. To avoid parallax, position your head so the meter scale, pointer and your eye are all in line. A mechanically stable adjustment can only be made when the direction of pointer travel is opposite to the direction of rotation of the adjust screw. The adjusting screws may be turned in either direction, but a good method is to turn the screw clockwise until the pointer swings up scale and then starts to swing down scale towards zero (i.e.: counter-clockwise). Continue turning the screw clockwise until the pointer (now moving to the left) is directly over the zero mark. If you overshoot, continue turning the screw clockwise until the pointer is again traveling down scale towards zero.

1-4 INSTALLATION INSTRUCTIONS

This instrument should not be operated in an ambient temperature greater than +50°C. Do not install the rack-mount model in a rack near other equipment discharging hot air around the Model 606A.

For personnel protection the power cord should be plugged into a 3-prong (NEMA approved) receptacle. If a 2-prong adapter is used, ground the instrument by connecting the external wire to ground. The receptacle box may be used if it is grounded.

1-5 CONVERSION FOR 230 VOLT OPERATION

The Model 606A may be quickly and easily converted for operation from a nominal 230 volt 50-1000 cps source. Refer to paragraph 4-3 CONNECTIONS FOR 230 VOLT OPERATION for instructions.

1-6 ACCESSORIES AVAILABLE

Output Termination -- 606A-34A
Fused Attenuator Protector -- 608A-95A. Prevents attenuator burnout when working with tranceiver type of equipment (requires two BNC to type "N" adaptors UG-201A/U and UG-349A/U).

SECTION II
OPERATING INSTRUCTIONS

2-1 OUTPUT TERMINATION

This instrument is calibrated ONLY when used with a 50 ohm resistive load, such as the Ⓗ Model 606A-34A Output Termination, into a high-impedance (500 ohms or greater) input. If the signal is fed into a lower impedance the output will no longer be within calibration specifications and the output of the Crystal Calibrator will be reduced, particularly on the higher harmonics.

Any shielded rf cable of 50 ohms nominal impedance with BNC male connectors is suitable for use with the Model 606A. Single braid shield types are suitable for use from maximum output to approximately -80 dbm (30 microvolts). Double braid or solid shield types are recommended for use over the entire attenuation range. A good general purpose cable consists of three feet of RG-55U (double braid shield) with UG-88C/U BNC connectors on each end. See also Figure 2-3 EXTERNAL OUTPUT TERMINATION for information concerning output cable termination.

The output jack on the Output Termination has been provided as a BNC connector for maximum shielding. Clip-lead connection may be provided easily by inserting a UG-290/U connector with soldered-on clip leads into the output jack of the Output Termination. Keep the length of the clip leads as short as possible.

2-2 SETTING THE CURSOR

Set the cursor (movable index) with the CALIBRATE knob so that it is aligned with the line under the engraving reading FREQUENCY before setting the frequency. The FREQUENCY dial is calibrated only after this operation is performed.

2-3 OUTPUT ATTENUATOR

The output attenuator contains resistors which can be burned out by careless usage. If the output is shorted out in the 3 VOLT range or if voltage is fed into the attenuator accidently, these resistors may be burned out or heated up so that they are no longer calibrated. This may occur while measuring the sensitivity of the receiver in a mobile transmitter-receiver installation when the transmit button is pushed accidently. An attenuator fuse is available as an accessory when it is desired to use this generator under conditions where the attenuator may be burned out (see paragraph 1-6). The resistors in the attenuator are NOT field replaceable. Do NOT open the attenuator to check these resistors as placement of the resistors is critical. The attenuator may be removed from the instrument and returned separately to the factory for repair.

2-4 USE OF THE 3-VOLT RANGE

The unusually high output range of 3 volts is useful for driving rf bridges or other equipment requiring a calibrated high-level high-frequency voltage. This useful range is obtained at the expense of operating the power amplifier stage near the overload point. You will obtain best life from these tubes by not leaving the generator on the 3 VOLT range any longer than necessary to make your measurement. Never leave it on this range during warm-up or stand-by.

2-5 EXTERNAL MODULATION

Take care when using external modulation with direct coupling. The dc level of the signal will affect the average rf level. If only modulation is desired or if only the ac component of the modulating signal has significance, switch the MODULATION SELECTOR to EXT. AC.

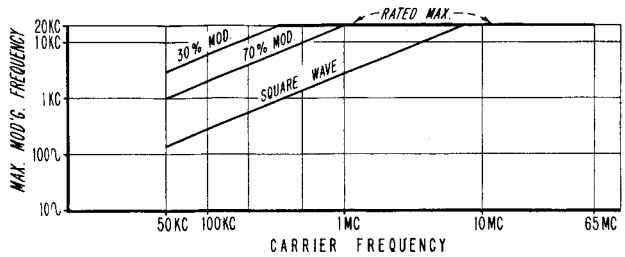
2-6 EXTERNAL SYNCHRONIZATION SIGNAL

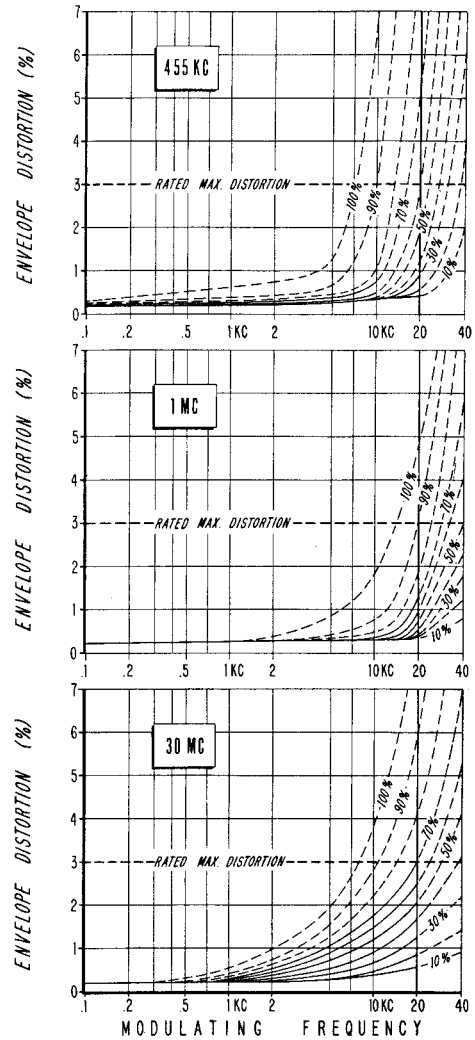
When the Model 606A is modulated internally a signal is available at the MODULATION Input-Output jack for synchronization purposes. This signal is fed from the same oscillator which modulates the carrier. It is of approximately 1 volt amplitude from a high impedance source. Since the signal comes from a high impedance source use it only as a voltage source and do not attempt to draw current.

2-7 B + FUSE

The regulated B+ voltage is fused on the front panel. If you accidentally apply excessive modulation to the instrument the tuned circuits may flash over from excessive peak rf voltage. This will blow the B + fuse. The instrument will have no output and the output level meter will be pinned to left of zero. If this happens, the fuse needs to be replaced to restore operation.

2-8 MODULATION DATA





OPERATING CONTROLS

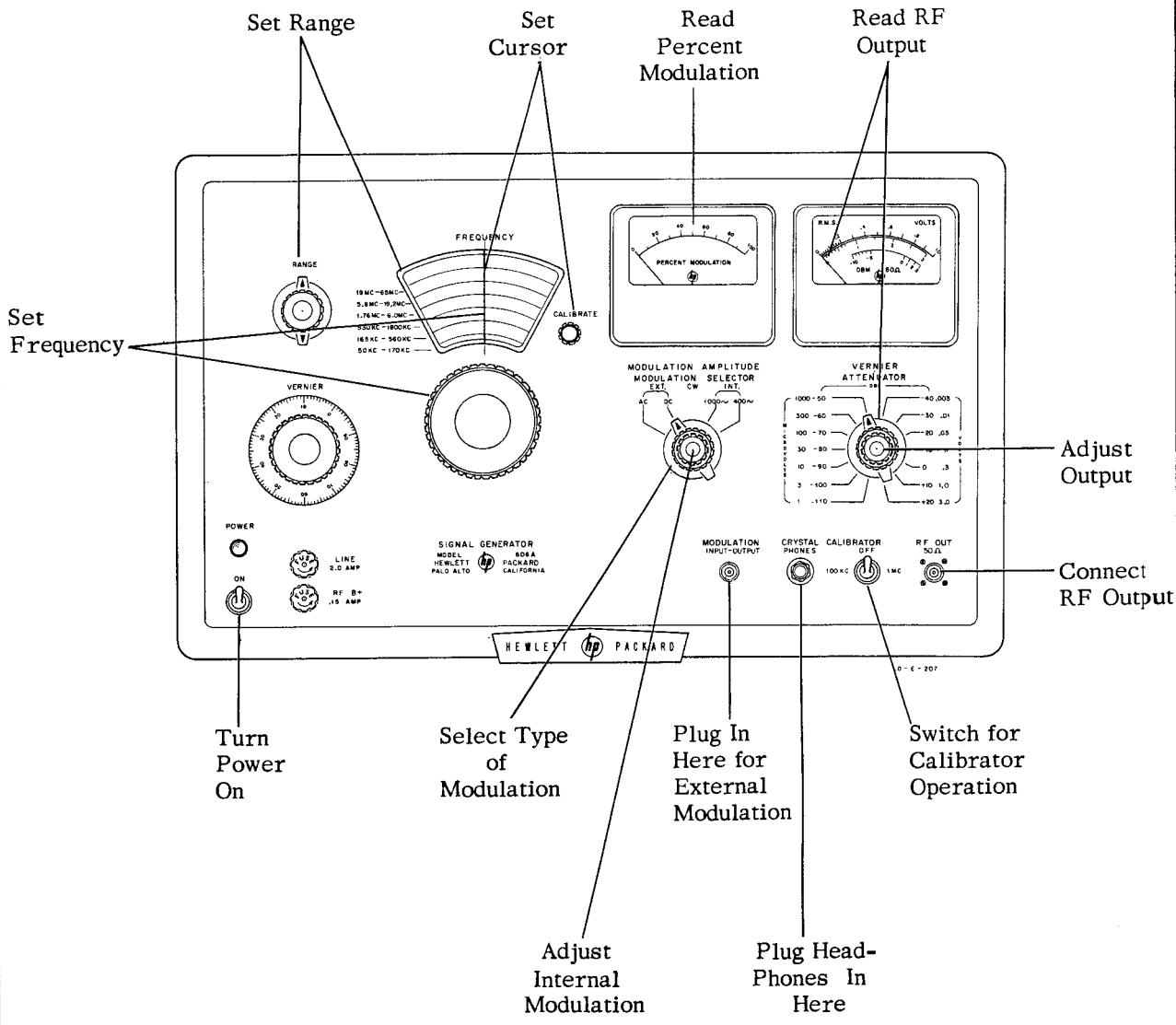
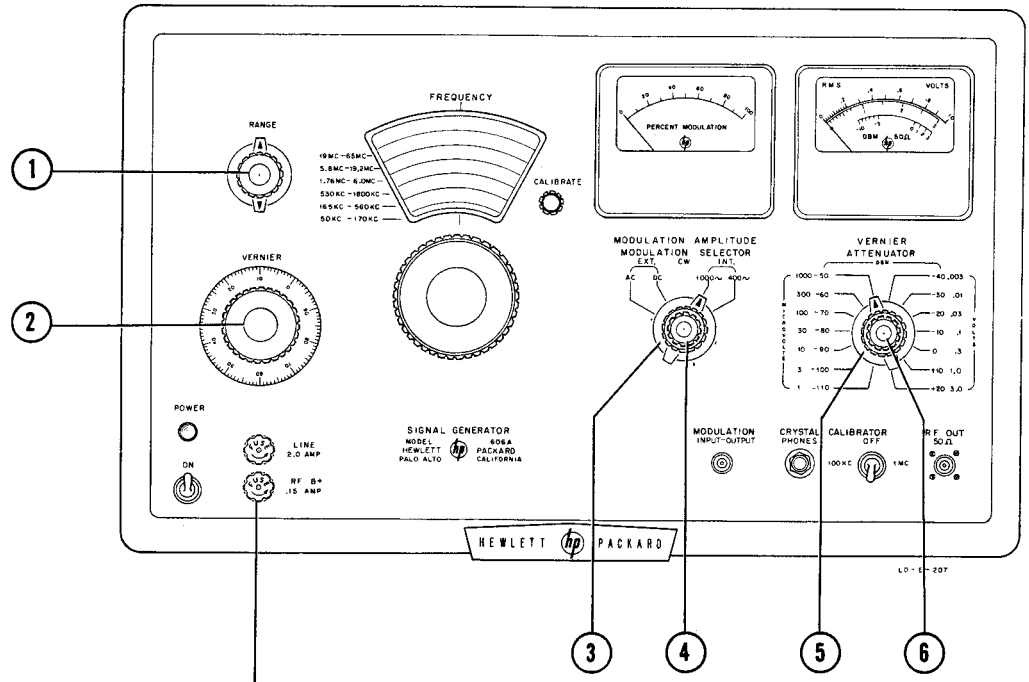


Figure 2-1

GENERAL OPERATION

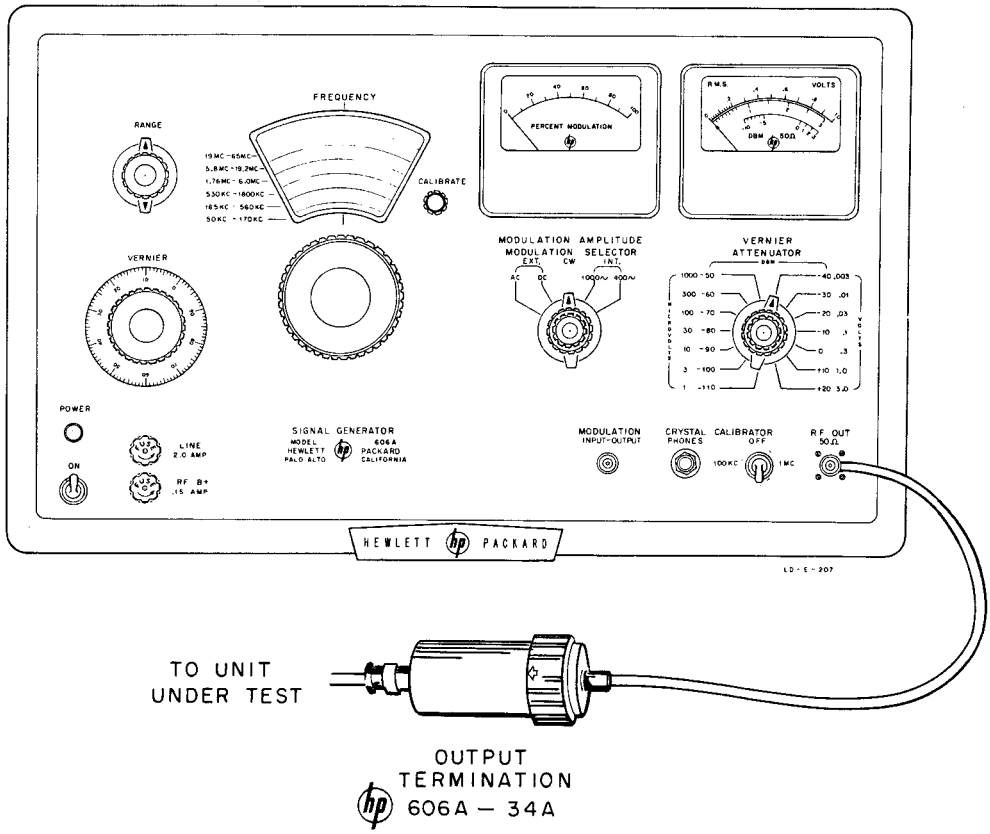


B+ FUSE NO R.F. OUTPUT AND OUTPUT METER PINNED TO LEFT IF BLOWN.

1. Rotate RANGE switch to select desired band.
2. Rotate FREQUENCY control to desired frequency. Read frequency on scale indicated by pointer.
3. Rotate MODULATION selector to INT(either 400 cps or 1000 cps modulation is available).
4. Set amount of modulation as read on PERCENT MODULATION meter with MODULATION AMPLITUDE control.
5. Rotate ATTENUATOR to select output voltage level desired.
6. Rotate ATTENUATOR VERNIER to desired output level. Read range of output meter on ATTENUATOR switch and value on meter.

Figure 2-2

EXTERNAL OUTPUT TERMINATION



The attenuator on the Model 606A Signal Generator is calibrated only when used with a load of 50 ohms. For high impedance loads or receiver inputs the output termination (hp Stock No. 606A-34A) is recommended. This output termination is designed for use at the end of a 50 ohm shielded cable, and to operate into a high impedance (500 ohms or greater) load.

The probe has three positions as the rear shell of the probe is rotated clockwise as follows:

a. Dummy Antenna - output impedance varies as per IRE Standard Dummy Antenna* at an output level 20 db below the input level (10:1 voltage division ratio).

b. Zero db attenuation - 25 ohms output impedance (1:1 voltage ratio).

c. Twenty db attenuation - 5 ohms output impedance (10:1 voltage division).

NOTE - Maximum permissible input power to probe is 18 milliwatts (3 volts across 50 ohms).

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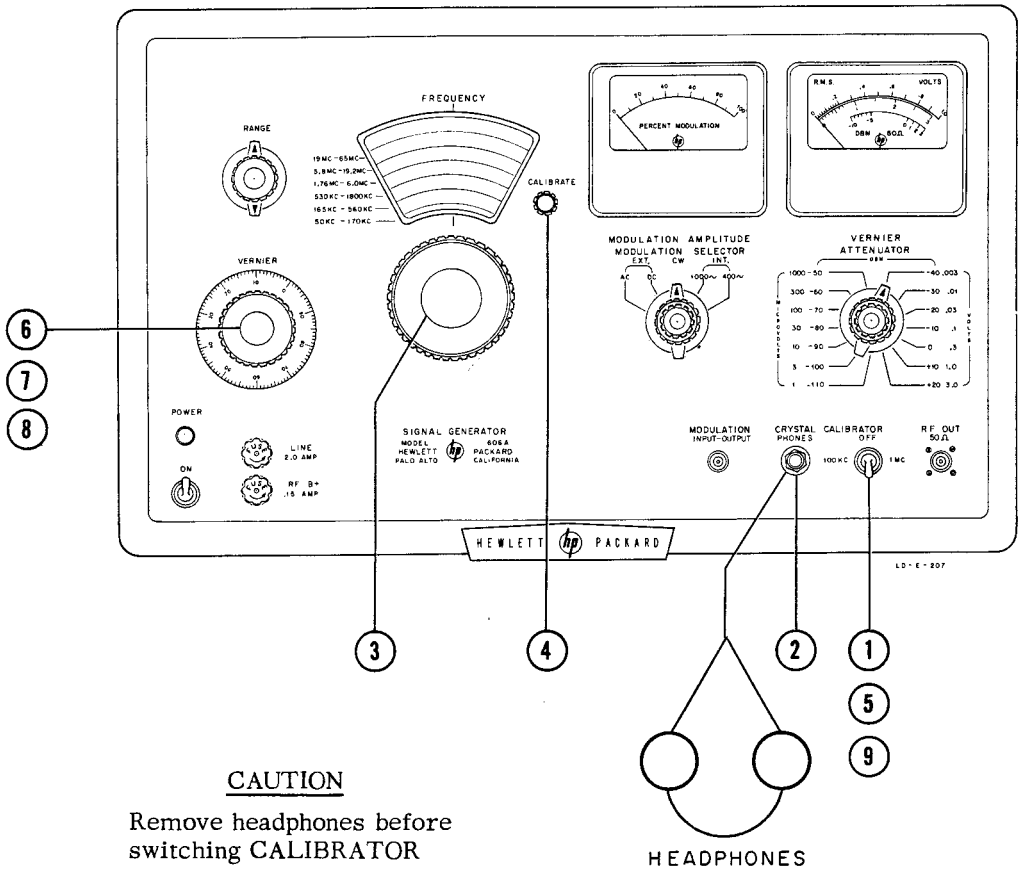
* See "Standards on Radio Receivers", Institute of Radio Engineers, 1938; and Terman, "Radio Engineers Handbook", any edition - section entitled "Measurements on Radio Receivers".

Figure 2-3

CALIBRATION



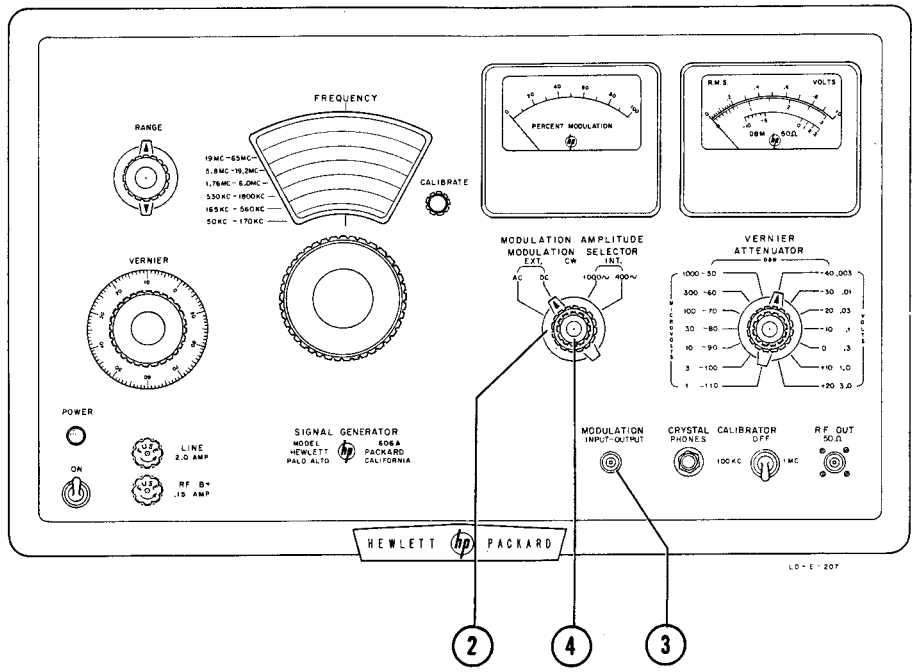
CAUTION

Remove headphones before switching CALIBRATOR

1. Switch XTAL CALIBRATOR to 1 mc.
2. Plug a set of high impedance headphones into PHONES jack.
3. Zero-beat nearest even megacycle division to desired frequency.
4. Set the cursor exactly on the megacycle mark.
5. Switch XTAL CALIBRATOR switch to 100 kc (lower frequencies only).
6. Turn VERNIER dial toward desired frequency while counting 100 kc beats. This procedure will set the frequency within 100 kc. If the frequency is desired with greater accuracy follow the remaining steps:
7. Determine number of scale divisions on VERNIER dial between zero-beat of the two 100 kc beats on either side of the desired frequency.
8. Set VERNIER dial to proportional number of divisions from nearest 100 kc beat to the desired frequency.
9. Turn XTAL CALIBRATOR to OFF. If left on it will modulate output signal.

Figure 2-4

EXTERNAL MODULATION



1. Perform procedure for CW operation (see Figure 2-2).
2. Set MODULATION SELECTOR to EXT (AC or DC coupling).
3. Connect modulating signal (3 volts or more adjustable) to MOD. terminal.
4. Turn MODULATION AMPLITUDE fully clockwise.
5. Increase signal from external generator until a reading of 100% is obtained on the PERCENT MODULATION Meter.
6. Reduce the percent modulation to the desired level with the MODULATION AMPLITUDE control.

The limits of modulation depend upon the maximum tolerable envelope distortion. For three percent envelope distortion the limits in terms of the carrier frequency, f_c, are:

	30% Mod.	70% Mod.	Square-Wave Mod.
$f_{mod.\ max}$ =	$.06\ f_c$	$.02\ f_c$	$.003\ f_c$
absolute $f_{mod.\ max.}$ =	20 kc	20 kc	3 kc

Applying these formulas, typical bandwidths are:

Carrier Freq.	Modulation Frequency		
Frequency	30% Mod.	70% Mod.	Square Wave
50 kc	3 kc	1 kc	150 cps
200 kc	12 kc	4 kc	600 cps
500 kc	20 kc	10 kc	1500 cps
1mc &above	20 kc	20 kc	3 kc

NOTE - On the 3 VOLT output range and between 19 - 65 mc in frequency, modulation beyond 30% is not recommended.

Figure 2-5

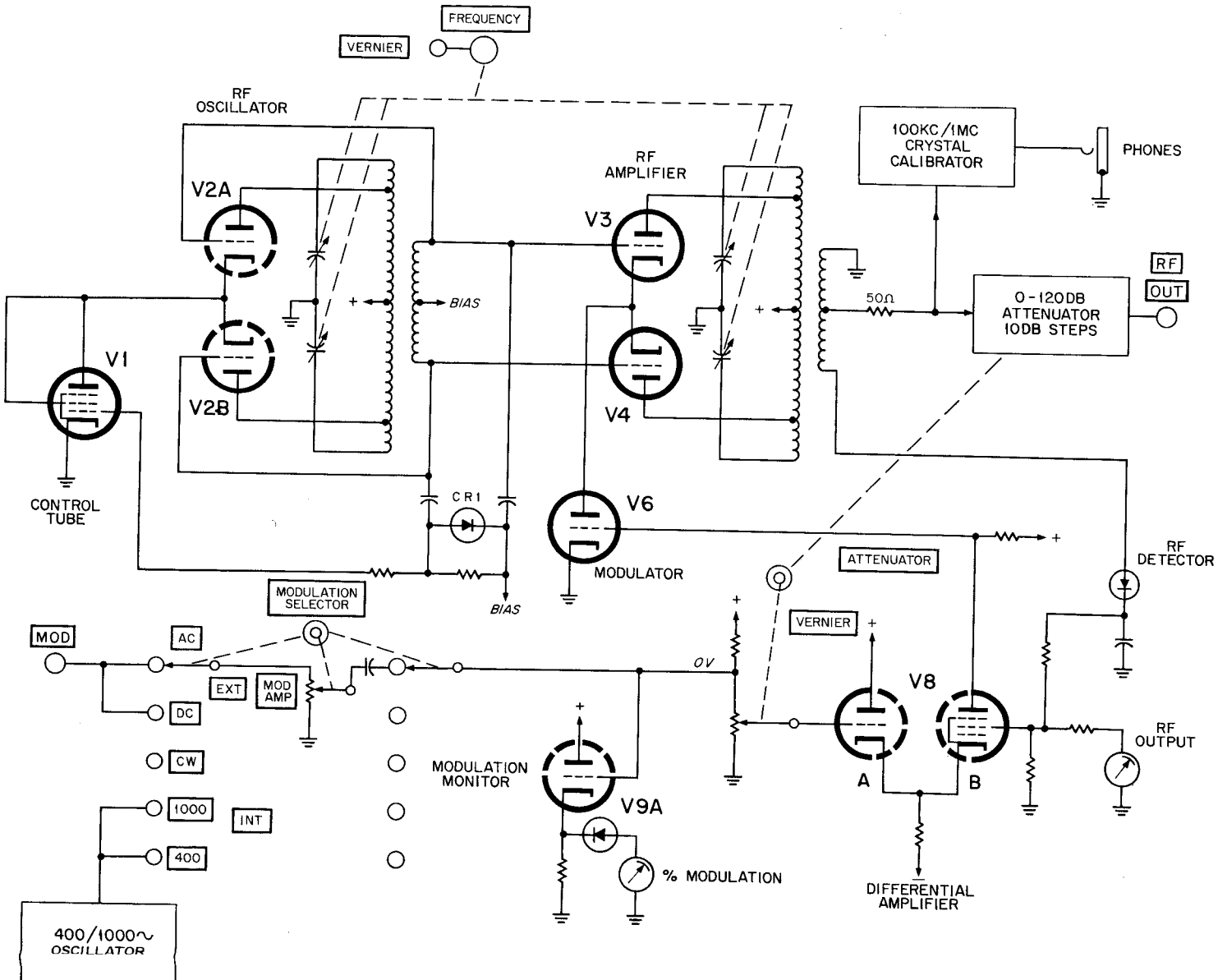


Figure 3-1. Block Diagram

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SECTION III
THEORY OF OPERATION

3-1 OVER-ALL OPERATION

Refer to the block diagram Figure 3-1. The level of the rf oscillator is stabilized by a feedback circuit from the RF Oscillator to the Oscillator Level Control tube. In a similar way the rf output and modulation levels are held constant by a feedback loop from the rf output through the Differential Amplifier to the Modulator. The rest of the block diagram represents standard circuitry for signal generators.

3-2 CIRCUIT DESCRIPTION

A. RF OSCILLATOR AND LEVEL CONTROL

The RF Oscillator is a tuned-plate push-pull oscillator. The pentode section of V1 acts as a variable cathode resistor for V2 to control the oscillator level. The control grid of this pentode receives a rectified portion of the oscillator signal. This voltage decreases the current through V1 when the oscillator level rises and vice versa. Since this current is also the cathode current of the RF Oscillator, the level of oscillation will be held constant. The triode section of V1 is a cathode follower which provides bias voltage for the grids of the oscillator and amplifier.

B. RF AMPLIFIER

The RF Oscillator signal is fed to the control grids of the push-pull RF Amplifier stage, V3 and V4. The screen grids are connected directly to +300 volts. The amplifier cathode current is controlled by V6, which acts as a variable cathode resistor. See the next paragraph for an explanation.

C. MODULATOR

Triode V6 is inserted in the cathode circuit of the RF Amplifier to obtain cathode modulation. The internal resistance of the triode changes according to the applied modulation signal at the control grid. Thus cathode current of the RF Amplifier is varied which, in turn, amplitude modulates the rf level.

D. RF FEEDBACK AND LEVEL CONTROL CIRCUIT

The modulated rf output signal is sampled at the secondary winding of the rf output transformer and rectified by crystal diodes CR2 and CR3. An rc filter passes the dc current developed. The time constant of the rc filter is determined by the position of the frequency RANGE selector. This time constant is selected to bypass the rf component but not the modulation. The demodulated rf signal is then fed to the control grid, pin 7, of the Differential Amplifier.

This demodulated signal is dc-coupled and thus has a dc component equal to the cw level of the output plus an ac component corresponding to the modulation. The demodulated rf signal also passes through a second rc filter, C37, C38 and L6, with a long time constant which removes the modulation. At the output of this filter a dc current is obtained which is proportional to the cw rf level. This current is then fed to the rf output meter.

A two-position attenuator, which controls the amount of feedback, is inserted between the crystal detectors and the differential amplifier. In the 1 VOLT and lower output positions the feedback is obtained through the divider R25 and R36. Only in the 3 VOLT position is R36 (in feedback loop) shunted by R26. This raises the current through the RF Amplifier by 10 db. This switching is done automatically by relay K1 whenever the ATTENUATOR selector is switched to the 3 VOLT position.

E. RF ATTENUATOR

The rf output signal is tapped off the secondary winding of the output rf transformer and fed to the input of the output attenuator. This attenuator

provides a maximum attenuation of 120 db in 10 db ranges. The output level may be varied between ranges by changing the input to the attenuator with the ATTENUATOR VERNIER control. Input is monitored by the rf level meter. The 3 VOLT rf output is obtained by reducing the dc component of the demodulated rf feedback.

F. CRYSTAL CALIBRATOR

A small signal, coupled from the attenuator, is fed to the control grid (pin 2) of a mixer amplifier (triode section of V10). The output of the crystal oscillator (pentode section of V10) is also fed to this grid. The mixed signal from V10 is fed into an output triode amplifier, V9B. The beat-frequency output of V9B is brought out to the front panel CRYSTAL CALIBRATOR OUTPUT phone jack.

The crystal oscillator consists of the pentode section of V10 operating as an electron-coupled oscillator. Positive feedback to the control grid is obtained from the screen grid through the crystals. Two crystals provide oscillation at either 1 mc or 100 kc, as selected by the XTAL CALIBRATOR switch. The plate of the oscillator provides the signal necessary to drive the mixer grid of the triode section.

G. AUDIO OSCILLATOR

The audio oscillator is a modified Wien Bridge oscillator with amplitude stabilization. The feedback signal is taken from the secondary winding of the output transformer. Two oscillator frequencies (400 and 1000 cps) can be selected by switching different resistors in the Wien Bridge. The level of oscillation is set by the MODULATION OSCILLATOR ADJUSTMENT (R51) which controls the feedback to the lamp. Increased feedback causes the lamp to heat up, increasing its resistance. The increased resistance causes more degeneration in the cathode of V5, limiting the gain.

In the INTERNAL positions the modulating voltage is available at the front panel MODULATION INPUT-OUTPUT jack. This voltage is supplied for synchronization purposes. It has a source impedance of 82K ohms.

H. PERCENT MODULATION METER CIRCUIT

The modulating signal goes to pin 2 of V9A, a cathode-follower. This tube feeds shunt diode CR5 which rectifies the signal. A dc voltage corresponding to the modulation is fed to the PERCENTAGE MODULATION meter. Clamp diode CR4 prevents the cathode of V9 from going negative to protect capacitor C56, whose voltage rating is 20 volts. This point would otherwise go towards -200 volts if V9 was removed or was weak.

The modulating signal also goes to pin 2 of V8. The signal level to V8 can be controlled by the ATTENUATOR VERNIER. When the signal level is varied the output modulation is varied, as explained in the following paragraph. This circuit is also used to reduce the voltage on the RF Amplifier during switching. As soon as the RANGE switch is rotated out of the detent position, S7 disconnects the +300 volt power supply, hence grid voltage of V8 drops to ground potential. The B+ is not reconnected until after the turret has made contact in its new position. This action keeps the amplifier tubes from drawing excessive screen current when the turret is disengaged from the plate circuit. When the +300 vdc supply is disconnected R64 is substituted as a load to keep the power supplies in regulation.

I. DIFFERENTIAL AMPLIFIER

The external modulation signal fed into the MODULATION jack is combined with the dc reference level in the same manner as the internal modulation. Either of these signals is applied to a resistive network consisting of R57, R62 and R68 and is added to the dc reference voltage. The combined voltages appear at the ATTENUATOR VERNIER (R63). This control varies the dc, which controls the carrier, and the modulation signal at the same rate. Thus the percentage of modulation remains constant regardless of carrier level.

The dc (carrier level) and ac (modulation) signals are fed through an rf filter to pin 2 grid of the triode section of V8 as a reference signal to be compared to a signal from the output which is fed to the pentode grid (pin 7). This triode plus the pentode section of the same tube form a differential amplifier. The ac level of both of these signals is proportional to the modulation. The modulating signal is the reference voltage and the actual modulation of the output is compared to this reference. The dc level of the output (proportional to the rf) is compared to a reference dc level that is proportional to the desired rf level, as set by the ATTENUATOR VERNIER control.

Since the cathodes of V8 are connected together, the reference signal applied to the triode section will also appear on the cathode of the pentode

section. This signal will be compared to the signal from the output which is applied to the grid. Any deviation from a fixed voltage difference between these two signals results in an output signal which has a polarity such as to reduce this difference. Thus the original conditions are restored. For example, if the rf level drops, the voltage on pin 7 of V8 will become more negative. This will reduce the amount of current flowing through this tube so the plate will become more positive. The grid voltage of V6 is proportional to the plate voltage of V8. As this grid voltage becomes more positive the current through V6 will increase. But this current is also the cathode current for the RF Amplifier, so the output will increase until the original conditions are restored. By this action the output is stabilized and is constant to better than ±1 db over the entire frequency range. The rf level can be changed by varying the ATTENUATOR VERNIER (R63) which will change the reference bias.

In a similar way the modulation is held constant. Since the crystal detector circuit has a time constant fast enough to follow the modulation envelope, the output modulation is compared to the modulating frequency and distortion is minimized.

J. BIAS SUPPLY

One half of V7 (pins 6, 7, 8 and 9) is a pentode cathode follower used as a constant voltage source to furnish the plate potential needed for the triode section of the differential amplifier.

The other half of V7 supplies the screen potential for the pentode section of the differential amplifier. The screen potential is adjusted for RF Amplifier cut-off when both grids of the differential amplifier are at ground potential. This establishes the zero point of the ATTENUATOR VERNIER control.

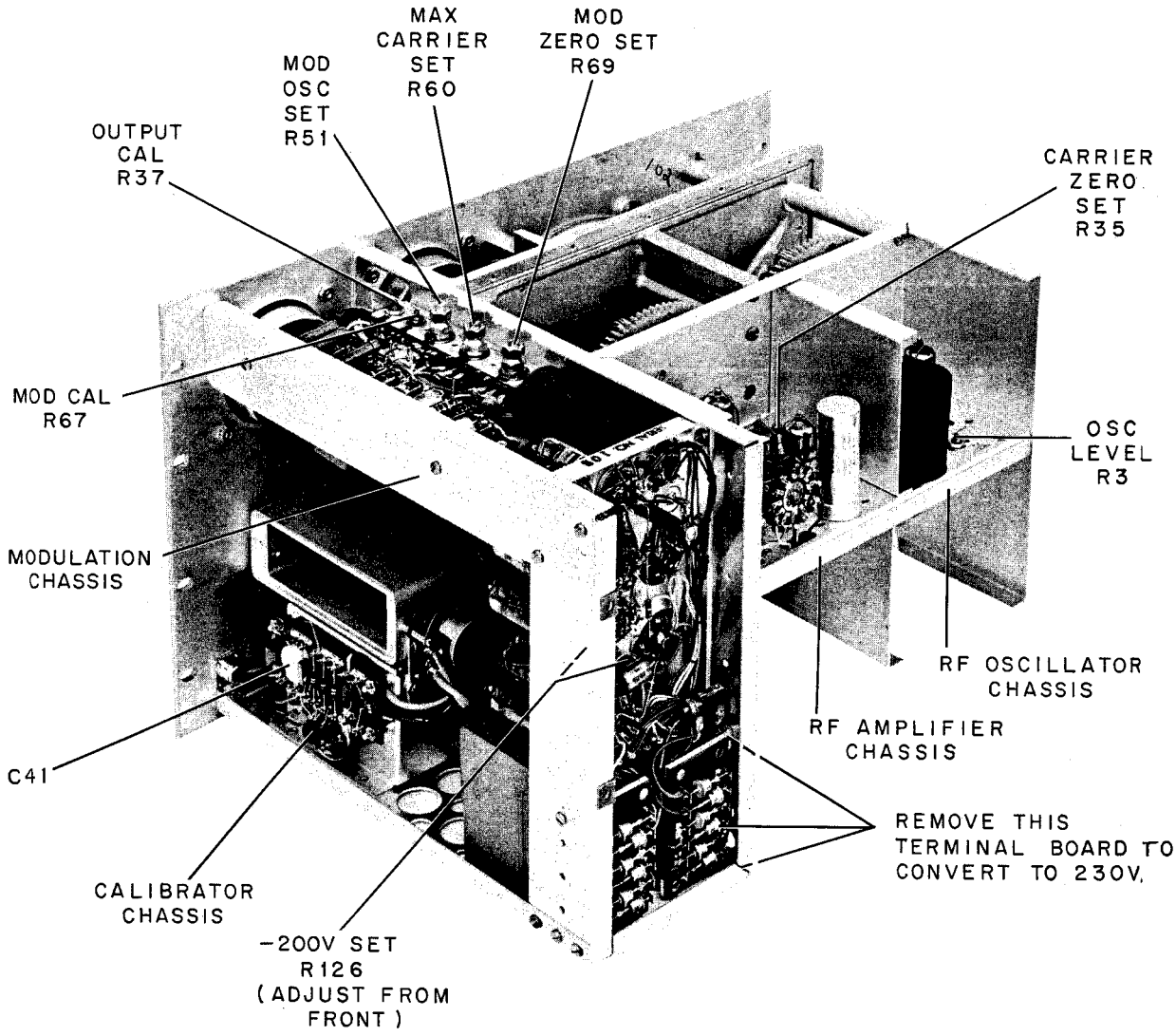


Figure 4-1. Location Diagram Model 606A

SECTION IV
MAINTENANCE

4-1 INTRODUCTION

This section contains instructions for adjusting and servicing the Model 606A Signal Generator.

Components within hp instruments are conservatively operated to provide maximum instrument reliability. In spite of this, parts within an instrument will fail. Usually, the instrument must be immediately repaired with a minimum of "down time". A systematic approach can greatly simplify and thereby speed up the repair.

Check the tubes if an instrument is completely inoperative and obviously not inoperative due to a burned out fuse, defective line cord, or power failure. Tube replacement will, in most cases, restore operation. See paragraph 4-4 for tube replacement information. A few adjustments may then be necessary and the instrument can be returned to service. Make only necessary adjustments.

4-2 REMOVING THE INSTRUMENT FROM THE CABINET

Disconnect the power cord from the receptacle. Remove the four screws on the rear cover of the cabinet. Remove the rear cover and unplug the inner chassis power cord from the rf filter box mounted in the cover. Tip the unit up on its back. Loosen the two screws on the bottom of the cabinet which clamp the cabinet to the panel. Do NOT remove any screws from the front panel. Lift the cabinet off the instrument. Except for the rf section the instrument is now open for servicing. Remove the rf shield only if necessary. Remove all screws holding the shield (use allen wrench clipped to top of shield to remove cap screws). Pull the shield to the rear and it will come off.

CAUTION

When the cabinet is removed dangerous voltages are exposed. Take adequate safety precautions.

4-3 CONNECTIONS FOR 230 VOLT OPERATION

The hp Model 606A Signal Generator can be quickly and easily converted to operate from a nominal line voltage on either 115 or 230 volts rms and a frequency of 50 to 1000 cps.

If the instrument is equipped with a special 115/230 volt power switch, conversion may be accomplished without removing the unit from the cabinet. Loosen the locknut and reverse the switch locking plate so that the lever on the power switch may be thrown to the 230 VOLT position. Tighten the locknut. Replace the LINE fuse with the fuse listed in the Table of Replaceable Parts for 230 volt operation. See 115/230 V power switch schematic for details.

If the instrument is not equipped with the 115/230 V power switch remove the instrument from its cabinet following the instructions given in the preceding paragraph. Remove the two screws holding the silicon rectifier terminal board nearest the center of the instrument (see Figure 4-1). Find the five-terminal tie-strip (located near the lead-in hole for the power cord going to the instrument) under the silicon rectifier board. Remove the shorting jumpers from the five-terminal tie-strip. Connect terminals 2 and 4 with an insulated jumper. Replace the silicon rectifier terminal board. Remove the LINE fuse and replace with the value listed in the Table of Replaceable Parts for 230 volt operation.

4-4 TUBE REPLACEMENT

In many cases instrument malfunction can be corrected by replacing a weak or defective tube. Before changing the setting of any internal adjustment, check the tubes. Adjustments made in an attempt to restore operation when the cause is a defective tube will often complicate the repair problem. See General Maintenance Information in paragraph 4-1.

Check tubes by substitution rather than using a "tube checker". The results obtained from the "tube checker" can be misleading. Before removing a tube, mark it so that if the tube is good it can be returned to the same socket. Replace only those tubes proved to be weak or defective.

Any tube with corresponding standard EIA characteristics can be used as replacement. Where variations in tube characteristics will affect circuit performance an adjustment is provided. Table 4-1 lists the tests to make and the adjustments that may be necessary if such tubes are replaced.

TABLE 4-1. TUBE REPLACEMENT

Circuit Ref.	Tube Type and Function	Tests and/or Adjustments
V1	6AW8 Oscillator Level Control	Set Maximum Oscillator Current; par. 4-15
V2	12AT7 RF Oscillator	Set Maximum Oscillator Current; par. 4-15
V3, 4	6CL6 RF Amplifier	Carrier Zero Set; par. 4-16 Maximum Carrier Set; par. 4-17 RF Output Meter; par. 4-19
V5	12AT7 Audio Oscillator	Audio Oscillator; par. 4-12 Mod. Zero Set; par. 4-17 Modulation Meter; par. 4-18
V6	12B4 Modulator	Maximum Carrier Set; par. 4-17 Mod. Zero Set; par. 4-17 RF Output Meter; par. 4-19 Modulation Meter; par. 4-18
V7	12AT7 Cathode Follower	Carrier Zero Set; par. 4-16 Maximum Carrier Set; par. 4-17 Mod. Zero Set; par. 4-17 RF Output Meter; par. 4-19 Modulation Meter; par. 4-18
V8	6AW8 Differential Amplifier	Carrier Zero Set; par. 4-16 Maximum Carrier Set; par. 4-17 Mod. Zero Set; par. 4-17 RF Output Meter; par. 4-19 Modulation Meter; par. 4-18
V9	12AT7 Modulation Monitor and Beat Frequency Output	Mod. Zero Set; par. 4-17 Modulation Meter; par. 4-18 Crystal Calibrator; par. 4-13
V10	6AW8 Crystal Oscillator and Mixer	Crystal Oscillator; par. 4-13
V101,2,3,4,5	12B4A Regulators	Power Supplies; par. 4-11
V106	6AW8 Amplifier	Power Supplies; par. 4-11
V107	12B4A Regulator	Power Supplies; par. 4-11
V108	6AW8 Amplifier	Power Supplies; par. 4-11
V109	5651 Voltage Reference	Power Supplies; par. 4-11

4-5 FRONT PANEL OPERATION CHECK

The following in-cabinet procedures are simple checks to be performed first whenever difficulty is encountered in operation of the signal generator. These checks will isolate the trouble to either the signal generator or associated equipment and if the trouble is in the signal generator will isolate it to a particular section. Always perform these checks before attempting to isolate the trouble within the instrument.

- Turn unit on with no load and allow to warm up five minutes or more.
- If output meter is off scale in the negative direction, check for blown B+ fuse.

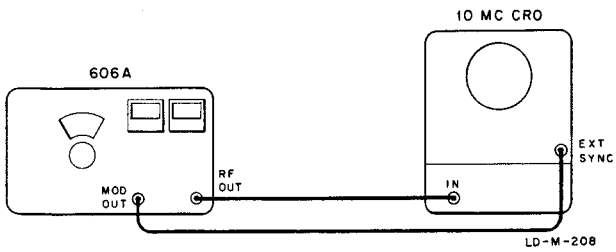


Figure 4-2. Modulation Meter Calibration

A. MODULATION METER CALIBRATION

1) Connect the unit to a 10 mc oscilloscope as shown.

2) Set RANGE switch to 530-1800 kc band.

3) Set FREQUENCY control to 1000 kc.

4) Set MODULATION SELECTOR to CW.

5) Set ATTENUATOR to 1 VOLT.

6) Adjust vertical sensitivity of oscilloscope to get 4 cm of deflection.

7) Set MODULATION SELECTOR switch to 1000∿.

8) Adjust MODULATION SELECTOR control until maximum deflection is exactly 6 cm high (see Figure 4-3). Modulation meter should be reading 50% ± 10%.

9) Increase MODULATION AMPLITUDE level. Distortion should be low up to 95% modulation.

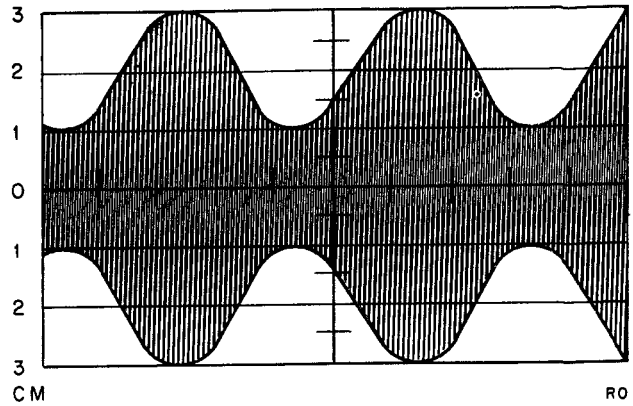


Figure 4-3. Waveform for 50% Modulation

B. FREQUENCY CALIBRATION

The easiest way to check frequency calibration is with a counter, such as the ℌ Model 524B/C/D with a 525B plug-in converter. If a counter is not available proceed as follows:

1) Allow both a receiver capable of receiving WWV and the Model 606A to warm up for fifteen minutes.

2) Tune in WWV on 5, 10, or 15 mc, whichever gives best reception.

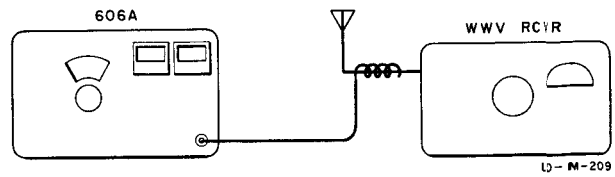


Figure 4-4. Frequency Calibration

3) Lightly couple a single wire from the RF OUT jack of the 606A to the antenna as shown.

4) Tune the RANGE and FREQUENCY controls of the 606A to the frequency of the incoming WWV signal. The MODULATION SELECTOR switch should be on CW (no modulation).

5) Adjust the output level to be about the same as WWV (use S meter on receiver if it has one). Too much signal will block the receiver and obscure the beat-note.

6) Zero-beat the frequency of the Model 606A to the WWV signal during a time that WWV has no modulation. Do not disturb the FREQUENCY dial after this adjustment. Set CALIBRATE adjustment to align window.

7) Listen to 1 MC CALIBRATOR with headphones. If beat-note is a low audio tone, less than 1 kc, crystal calibrator is within specifications.

8) Repeat step 7 using 100 KC CALIBRATOR.

9) With the CALIBRATOR on 1 MC check all mega-cycle marks on the dial on all bands. Beat-note should be within 1% of the dial reading.

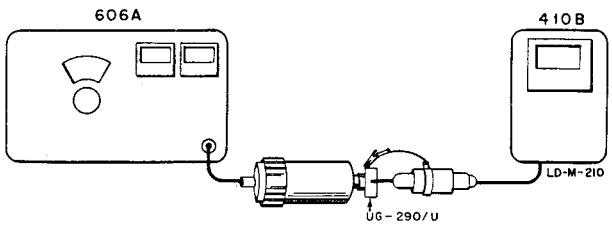


Figure 4-5. Output Level Frequency Response

C. OUTPUT LEVEL FREQUENCY RESPONSE

1) Connect AC Probe of hp Model 410B High Frequency VTVM to Output Termination as shown. Solder tip of 410B ac probe to center conductor of UG-290/U connector. Clip ground lead of probe to skirt of connector. Insert connector into OUTPUT connector of Output Termination.

2) Set the output to 0.9 volts on the 530 KC-1800 KC band and run the FREQUENCY dial and RANGE switch throughout all bands. The voltage should not vary more than ±11% (1 db) at any output level setting.

4-6 TROUBLE SHOOTING

In general, internal controls have only a limited range and are designed to compensate for minor variations in tubes and/or circuit components. If a major section or the complete instrument is inoperative adjustment of internal controls will seldom, if ever, restore operation. To avoid complications and reduce "down time" locate and correct the cause of a dead instrument before you make internal adjustments. Refer to paragraph 4-1 before making internal adjustments.

A good starting point when repairing a dead instrument is with the power supply. Check line cord, both fuses, and the power supply output voltages. BE SURE TO CHECK THE B+ FUSE IN ADDITION TO THE MAIN FUSE, ESPECIALLY IF THE OUTPUT METER IS PINNED TO THE LEFT. If you find a dead power supply tube, tube replacement will normally restore instrument operation without any internal adjustments. However, check the output voltages of each supply to see if the output is within limits. If the output is within the limits given in the Power Supply section do not attempt to refine the adjustments.

When a section shows up faulty in the above procedure refer to the appropriate section of Table 4-2 and perform the recommended tests. If the trouble is in the output termination or attenuator you may return them separately to the factory for repair. They are NOT field repairable.

Resistors R9 and R15 in early models were 1/2 watt resistors which burned out when the variable tuning capacitors were shorted with dust. If these resistors burn out replace them with the 5 watt type specified in the parts list. They are located on the turret stator contacts beneath the chassis and may be replaced readily without removing the rf shield. IF THE INSTRUMENT IS INOPERATIVE, FIRST TRY BLOWING OUT THE PLATES OF THE TUNING CAPACITOR WITH A LOW VELOCITY AIR STREAM SUCH AS THAT FROM A VACUUM CLEANER. Blow out these plates every time you remove the instrument from the cabinet for maintenance.

TROUBLESHOOTING CHART, TABLE 4-2

Since the operation of many sections in this generator is dependent upon the proper operation of other sections, troubleshooting in this instrument must be done in proper sequence. After determining in which section the trouble lies, refer to the appropriate section of this chart and perform the tests indicated. Also, if the trouble cannot be found by any other means, go through this chart from the beginning. Once the trouble has been found and fixed do not continue on with the tests in this table.

If output is obtained, troubleshoot the particular section giving difficulty by referring to the appropriate part of Table 4-2, Troubleshooting Chart.

If no output is obtained, the trouble may be anywhere in the feedback loop. Refer to Table 4-3, Troubleshooting the Feedback Loop, for instructions.

TABLE 4-2. TROUBLESHOOTING CHART

Measure	Normal Indication	Possible Cause of Malfunction
A. -200 VDC SUPPLY		
PREPARATION: Disable +300 vdc Supply by disconnecting R101 (5 ohm 5 watt wirewound resistor found just above rectifier terminal boards at rear of instrument). Temporarily connect a 1 megohm 1 watt resistor between pins 2 and 9 of V107. Measure the voltage to ground at the following points:		
1. C108 filter cap.	-200 vdc ±5%	C108 open or shorted, also disconnect load and remeasure.
2. Transform. sec. (blue)	286 vrms ±10%	Open or shorted secondary.
3. C105 unreg. dc	-200 vdc ±10% (one side) +195 vdc ±10% (other side)	Open or shorted C105. Open or shorted CR105-108.
4. V107 pin 9 (plate)	+195 vdc (nominal) ±20% (depends upon components)	V107 (12B4) defective. Check heater (6.3 vrms).
5. V109 pins 1, 5 (plate)	-110 vdc (nominal) ±20%	V109 (5651) defective. Check for orange glow.
6. V108 pins 1, 6 (cathode)	-112 vdc (nominal) ±20%	V108 or associated components defective; check heater (6.3 vrms).
B. +300 VDC SUPPLY		
PREPARATION: The -200 vdc Supply is assumed to be operating (remove 1 megohm resistor and reconnect +300 volt supply if these temporary changes were made to troubleshoot -200 vdc supply). Adjust line to 115 vrms.		
1. C104 filter cap.	+300 vdc ±5%	Also measure with RANGE switch between ranges; this will isolate a defective tuning capacitor in RF OSC. or AMP.
2. Transf.sec.(red)	+175 vrms ±10%	Open or shorted turns in transformer.
3. C101 and C102	250 vdc across each	C101, 102 and 104 or CR101, 102, 103 and 104 open or shorted.
4. V101 pin 9 (plate)	+500 vdc	C101, 102 or CR101, 102, 103 and 104 open or shorted. Check V101, 102, 103, 104, 105 and 106.
5. V106 pin 9 (plate) pin 8 (screen) pin 6 (cathode)	 +270 vdc + 38 vdc - 3.6 vdc	 V106, R102, 103 and 104. V106, C103, R110, R111 and -200 volts. V106, R113 and -200 volt supply.

TABLE 4-2. TROUBLESHOOTING CHART (CONT'D.)

Measure	Normal Indication	Possible Cause of Malfunction
C. RF OSCILLATOR		
PREPARATION: This procedure assumes the power supply is operating correctly. Use a clip-lead to short across R30 (caution -200 volts) to disable RF Amplifier temporarily while measuring the following voltages: (Measure voltage to ground)		
1. V2 pin 9 (tie point)	+26 vdc ±10%	Check voltage at RF Filter · Check voltage at junction of CR110 and 112.
pin 5 to 9	6.3 vdc ±10%	Open heater-check for visible glow.
2. V1 pin 5	+26 vdc ±10%	Same as step 1, V2 pin 9
pin 4 to 5	6.3 vdc	Same as step 1, V2 pin 5 to 9.
pin 3	+ 295 vdc (nominal)	Check B+ fuse, detent micro-switch S7, rf filter (C8, 10ABC, 11, 16, 32 and 33 for shorts, L4 for open circuit). Turn range switch between ranges-should be no change.
pin 2	+99 vdc	Check R1, 2, 3 and C1.
pin 1	+100 vdc	Check R19, V1 or rf lead to 6CL6's.
3. V2 pin 1 & 6 (plates)	+295 vdc (nominal)	Check R9, and C4, 5 and 7 for shorts.
pin 2 & 7 (grids)	+100 vdc	Check V1 and assoc. components.
pin 3 & 8 (cath.)	+110 vdc	Check V1, 2, CR1 or assoc. components.
pin 1 & 6 (plates)	6 vrms (nom.) to 19 mc 3 to 5 rms to 65 mc (meas. with ℗ 410B-AC Probe).	Check V2, CR1, C4, 5, 7, T2 (tank coil) and grid line to 6CL6's.
4. R9 (turn off and measure resistance)	100 ohms ±10%	Check C4, 5 or V1 or V2 for shorts.
D. RF AMPLIFIER		
PREPARATION: This procedure assumes the power supply and oscillator are operating. (Disconnect short across R30, if installed in step C.) Measure Voltage at:		
1. C34	+26 vdc ±10%	C34, 35, 36, L5, R132, V1-4 and V6-8.
2. V3, 4, 7 & 8 (acr.htrs)	6.3 vdc ±10%	Same as above.
V6	12.6 vdc ±10%	Same as above
3. R15 at tank term.	+ 295 vdc ±10%	R15 open, C10C, 11 shorted.

TABLE 4-2. TROUBLESHOOTING CHART (CONT'D.)

Measure	Normal Indication	Possible Cause of Malfunction
	RF AMPLIFIER (Cont'd.)	
4. V8 (6AW8)		
pin 2	0 to +4.5 vdc as R63 is rotated	R31, 53, 57, 60, 61, 62, 64, 65 and 68.
pin 6	+4.1 vdc (nominal)	C29, R32, 33, 34, 35, V7, 8.
pin 9	+76 vdc (nominal)	R20, 22, 23, 29, 30, V8.
pin 3	+150 vdc (nominal)	C28, 29, R33, 34, 35, V7.
pin 8	+54 vdc (nominal)	Same as pin 3.
pin 7	0 to+4 vdc as R63 is rotated	C23, 24, 25, CR2, 3, R17, 24, 25, 26, 36, V8.
5. V6 (12B4)		
pin 2, 7	-10 to -25 vdc as R63 is rotated	C19, R20, 22, 23, 29, 30, V7 or 8.
pin 9	+110 vdc (nominal)	R10, 38, V3, 4, 6.
6. V3 and 4 (6CL6's)		
pin 6	+295 vdc (nominal)	Shorted C12, 14, 15, open T3 or contacts on turret.
pin 3, 8	+295 vdc (nominal)	Check C10, 11, 14, 15, 16, R10, 15
pin 2, 9	+100 vdc (nominal). If this voltage is incorrect the RF Oscillator is not functioning properly.	R11, 12, triode section of V1.
pin 1	+112 vdc (nominal)	R13, 14, check voltage on pin 9 V6.
7. CR2, anode	6 vrms (nominal) with 1 VOLT output level. Varies 0 to 6 vrms as ATTENUATOR VERNIER is turned.	Check V3 and 4 plate voltage and output voltage as given in Table 4-4.

Symptom	Possible Cause
8. Fuse F1, (.15 amp) burns out	Defective C8, 10 ABC, 32, 33, 53 and L1, 4. Foreign material across tuning capacitors: C4, 5, 7, 14, 15 and 18. Defective microswitch S7. Feedback system defective.
9. Sharp drop (hole) in power output level, or a sharp increase (peak) in oscillator or amplifier current as frequency dial is tuned.	Check shorting fingers in turret. This prevents next lower band coil from resonating and absorbing power.
10. R15 (100 ohms) burns out.	Shorted tuning capacitor C14, 15 or 18. Open or shorted CR2, 3. Shorted C23, 24, 25 or S3. If this condition affects one band only, check the turret contact and coil for that one band. Also check switch S3 (on rf deck) for shorts. If this condition persists on all bands see Table 4-3.

TABLE 4-2. TROUBLESHOOTING CHART (CONT'D.)

E. AUDIO OSCILLATOR

The Audio Oscillator is straightforward. Most troubles can be found easily by measuring the voltages in the circuit as follows:

PREPARATION: Set MODULATION SELECTOR to INT. 1000 ∿.
MODULATION AMPLITUDE to 100%.

V5 (12AT7)		
pin 1	3.7 vrms	+180 vdc (approximate voltages)
pin 2	6.6 vrms	0 vdc
pin 3	6.2 vrms	+2.4 vdc
pin 6	80 vrms	+292 vdc
pin 7	3.8 vrms	0 vdc
pin 8	1.88 vrms	+4.1 vdc
T1 leads		
green	20 vrms	0 vdc (approximate voltages)
yellow	3 vrms	0 vdc
blue	80 vrms	+292 vdc

F. MODULATION MONITOR

The Modulation Monitor circuit is straightforward. Most troubles can be found easily by measuring the voltages in the circuit as follows:

PREPARATION: Set MODULATION SELECTOR to INT. 1000 ∿.
MODULATION AMPLITUDE to 100%.

V9A (1/2 12AT7)		
pin 2	2.8 vrms	0 vdc (approximate voltages)
pin 3	2.3 vrms	+3.9 vdc

Diode CR4 (1N90) prevents a high negative voltage developing at the cathode of V9A during warmup. Such a high voltage of reversed polarity would damage electrolytic capacitor C56. The high negative voltage could also be developed if the heater of V9 burned out or if the instrument was turned on with V9 removed.

Diode CR5 (1N90) is the detector for the Modulation Meter.
Both diodes can be measured only out of the circuit. Forward resistance should be approximately 500 ohms. Back resistance should be greater than 100K ohms.

G. CRYSTAL CALIBRATOR

The Crystal Calibrator is straightforward. Most troubles can be found easily by measuring the voltages in the circuit as follows:

PREPARATION: Set CRYSTAL CALIBRATOR to either 100 KC or 1 MC as indicated.

	100 KC		1 MC		
V10 (6AW8A)	DC	AC	DC	AC	
pin 1	0 vdc	0 vrms	0 vdc	0 vrms	
pin 2	-58 vdc	41 vrms	-34 vdc	23 vrms	
pin 3	+71 vdc	.44 vrms	+196 vdc	.1 vrms	all
pin 6	0 vdc	0 vrms	0 vdc	0 vrms	voltages
pin 7	-82 vdc	60 vrms	-35 vdc	23 vrms	approximate
pin 8	+108 vdc	31 vrms	+122 vdc	7.5 vrms	
pin 9	+240 vdc	41 vrms	+222 vdc	22 vrms	

TABLE 4-3. TROUBLESHOOTING THE FEEDBACK LOOP

Symptom: No output on all ranges, or R15 (100 ohms) burns out on all ranges.

Preparation: This procedure assumes that:

1) The -200 volt and +300 volt supplies are functioning properly.
2) All heater voltages in the rf chassis measure the correct value.
3) All tubes have been checked.
4) The oscillator must be working properly on all bands and give approximate voltages and currents as listed in Table 4-4.
5) The tuning capacitor or its leads are not short circuited.

Procedure: Unless otherwise noted all measurements are made at 115 vrms 60 ∿ line, with the 606A on CW.

Proceed from step to step and rectify any troubles before proceeding to the next step.

Measurements are made with an ⓗⓟ Model 410B VTVM and Model 428A Clip-On Milliammeter, or other milliammeter.

E = dc voltages; e = ac voltages; I = current.

Procedure	Observe or Measure
1. Disable the feedback by connecting pin 2, V6 (12B4) to -200 volts by shorting R30 (220K)	This bias should cutoff V6 and provide no current for V3 or V4. There should be no current through R15. Check with ⓗⓟ 428A.
2. Connect a series combination of 5K, 5W, fixed and a 2K, 2W variable resistor from pin 9 of V6 (12B4) to ground. Adjust 2K pot. to obtain 1 volt at 1 mc.	V6 (12B4) pin 1 to gnd, I_K is approx. 19 ma R10 (33K) " " " 5.6 ma R38 (33K) Bands 1-5 " " " 5.6 ma Band 6 " " " 0 ma V3 or V4 (6CL6) pin 6 to gnd e is approx. 7.8 vrms pin 1 to gnd " " " 5.9 vrms pin 1 to 2 E " " -14 vdc pin 6 to gnd " " " +295 vdc pin 8 to gnd " " " +295 vdc pin 7 to gnd " " " +110 vdc R13 or 14 (39Ω) " " " 0.15 vdc CR2 (anode) e " " 5.7 vrms CR3 (cathode) E " " 7.1 vdc V8 (6AW8) pin 7 to gnd E " " 3.1 vdc pin 7 to gnd e " " 0 vrms R18 (50 ohms) input voltage is approx. 2 vrms output voltage is 1 vrms.

TABLE 4-3. TROUBLESHOOTING THE FEEDBACK LOOP (CONT'D.)

Procedure	Observe or Measure
3. Repeat for bands 1, 2, 4, 5 and 6	Check with data on Table 4-4. Data for CR2, CR3 and V8 for this test are same as listed in item 2.
4. Adjust the 2K variable resistor until 3.1 vdc appears on pin 7 of V8 (6AW8A). Set R63 (ATTENUATOR VERNIER) fully counter-clockwise (zero ohms).	V8 (6AW8A) pins 1 & 6 E is approximately +3.9 vdc pin 2 " " " 0 vdc pin 3 " " " +143 vdc pin 4 " " " +19.5 vdc pin 5 " " " +13 vdc pin 7 " " " +3.1 vdc pin 8 " " " +77 vdc pin 9 " " " +10 vdc V7 (12AT7) pins 1 & 6 E is approximately +295 vdc pin 2 " " " +74 vdc pin 3 " " " +77 vdc pins 4 & 5 " " " +19.5 vdc pin 7 " " " +135 vdc pin 8 " " " +143 vdc pin 9 " " " +13 vdc
5. Turn R63 (ATTENUATOR VERNIER) fully clockwise (5K).	V8 (6AW8A) pins 1 & 6 E is approximately +4.5 vdc pin 2 " " " +3.3 vdc pin 3 " " " +138 vdc pin 6 " " " +4.5 vdc pin 7 No voltage change as R63 is rotated pin 8 E is approximately +77 vdc pin 9 " " " +42 vdc
6. Disconnect jumper from pin 2 V6 to -200 volts. Remove 5K and 2K resistor	The unit should be working properly.
7. Realign the RF Oscillator and Amplifier sections if any tubes or components have been replaced or altered	See section on Max. Carrier Set, Mod. Zero Set, Carrier Zero Set, Percentage Mod. and Carrier Output Meters.

TABLE 4-4. TYPICAL RF VOLTAGE (1). OSCILLATOR AND AMPLIFIER CURRENTS OUTPUT 1 VOLT INTO 50 OHMS, CW

FREQ. (6)	I_o (2)	e_{go} V2 pin 2,7	e_{po} V2 pin 1 or 6	e_{ko} @C4/ C5	I_a (3)	e_{ga} V3 or 4 pin 2	e_{pa} V3 or 4 pin 6	e_{ka} @C14/ C15	e_{out} term. (5)	e_{fb} term. (4)	I_k 12B4 V6 pin 1
94 KC	1.3 ma	7.1 v	92 v	209 v	5.7ma	7.1 v	9.3 v	58 v	2.0 v	5.5 v	19 ma
310 KC	2.8	7.0	70	150	4.9	7.1	9.8	31	2.0	5.3	19
1 MC	4.8	5.9	130	130	6.4	5.9	7.8	19	2.0	5.7	19
3.33 MC	5.3	6.7	93	93	7.6	6.8	19	19	2.0	5.5	26
10.9 MC	4.6	6.9	55	55	4.0	6.85	15.5	15.5	2.0	5.5	17
36.3 MC	14.0	6.6	24.5	25	9.4	5.3	6.8	6.8	2.0	5.5	26

NOTES:
(1) Measured by DC VTVM, such as hp Model 410B.
(2) Measured by hp Model 428A Clip-On Milliammeter at red-green wire loop between B+ and R9 (beneath RF Oscillator stator turret contacts).
(3) Measured by hp Model 428A Clip-On Milliammeter at red-green wire loop between B+ and R15 (beneath RF Amplifier stator turret contacts).
(4) Feedback voltage terminal (4) next to diode detector CR2.
(5) Output voltage terminal (5) next to generator terminating resistor, R18.
(6) Leave dial set at 1 MC, rotate range switch only to desired band.

Explanation of symbols:
e = voltage; I = current; g = grid; o = oscillator; k = cathode; a = amplifier; f = filament; p = plate

4-7 TURN-ON PROCEDURE FOLLOWING REPAIR

Be sure to check for shorts in tuning capacitors C4 & 5 and C14 & 15 with an ohmmeter after repair and before turning on the instrument. Solder splashes may occur which short these capacitors when repairing other parts of the instrument. If the instrument is turned on with these capacitors shorted, resistors R9 or R15 may be damaged.

4-8 TEST EQUIPMENT REQUIRED

The following equipment is required to test the Model 606A:

- A VTVM accurate to ±3% with a high frequency probe, such as the hp Model 410B Vacuum Tube Voltmeter.
- An ac voltmeter accurate to ±2%, such as the hp Model 400D/H/L Vacuum Tube Voltmeter.
- A clip-on dc milliammeter, such as the hp Model 428A Clip-ON DC Milliammeter or a conventional 300 ma milliammeter.
- An electronic counter, such as hp Models 524B/C/D Electronic Counters with Model 525A Converter.
- An oscilloscope, such as hp Model 150A.
- A variable transformer continuously adjustable over the range 100-130 v, equipped with a monitor voltmeter accurate within 1 volt.
- A square-wave generator, such as the hp Model 211A Square Wave Generator.

4-9 METER ZERO ADJUSTMENT

Both meters should read zero when the instrument is turned off. If both of the meters do not read zero proceed as follows:

Preheat instrument and turn off -
A mechanically stable adjustment can only be made when the direction of pointer travel is opposite to the direction of rotation of the adjust screw. The adjusting screw may be turned in either direction, but a good way is to turn the screw clockwise until the pointer swings up scale and then starts to swing down scale toward zero (i.e.: counterclockwise). Continue turning the screw clockwise until the pointer (now moving to the left) is directly over the zero mark. If you go too far, continue turning the screw clockwise until the pointer is again traveling down scale towards zero.

4-10 GENERAL TEST AND ALIGNMENT INSTRUCTIONS

Usually a particular instrument will not need complete test and adjustment. This is particularly true when repair has been accomplished without changing any internal adjustments. BEFORE MAKING ANY INTERNAL ADJUSTMENTS, READ ALL OF PARAGRAPHS 4-1 and 4-4. If unnecessary adjustments are eliminated you will often save time by being able to finish a repair without completing the entire test and adjustment procedure.

The procedures are listed in a recommended sequence for a complete test and adjustment operation. Test instrument recommendations are given in paragraph 4-8, Test Equipment Required. The test frequencies and voltages are based upon the use of these recommended instruments. If other equipment is substituted, you may have to alter the procedures accordingly. When other equipment or methods are used, it is important to select components and techniques which have equal or greater accuracy. Any instrument can be adjusted for optimum performance at a particular frequency or voltage, or the most commonly used range.

The specifications for your instrument are given in the front of this manual. The test procedures contain extra checks to help you analyze a particular instrument. These extra checks and the data they include are not to be considered as specifications.

A ten to fifteen minute warmup at normal line voltage (nominally 115/230 volts) and power supply output voltage measurements are always recommended before making any other tests or adjustments. Refer to paragraph 4-11 before making any power supply adjustments.

4-11 POWER SUPPLIES

The power supplies in this instrument are extremely stable and will require infrequent adjustment. The output voltages may be measured at regular intervals or as a first trouble-shooting step but unnecessary adjustment should be avoided. A defective tube or component may overload the power supply and lead you to believe that the power supply is not functioning properly.

As long as the power supply regulator is functioning properly, you need not know the absolute values of the power supply output voltages. However, when power supply adjustment is necessary, you should use a voltmeter with a known calibration accuracy.

Regulation of the power supply can be checked by varying the power line voltage between 103 and 127 volts. The output voltage will vary only slightly, if at all, from the value measured with a 115 volt line. Loss of power supply regulation is most easily detected, as a sudden large increase in power supply ripple as the line voltage is raised and lowered ±10% from 115 volts.

When the power supply output voltages are within limits with the line voltage at 115 volts, adjustment is not necessary. Do NOT adjust in an attempt to refine the existing control settings.

To test the power supplies proceed as follows:

1) Measure power supply outputs. They should be within the limits shown in Table 4-5.

2) If the voltage is outside the limits in the table adjust R126 (-200 V Set) for -200 volts. This control is in the center of the power supply deck with access only from the front side of the chassis.

3) You may wish to check the regulation of each power supply as the line voltage is varied between 103 and 127 volts. All regulated voltages should remain within ±1% over this range of line voltage.

4) Measure the ripple voltage on the various supplies. They should approximate the values indicated in Table 4-5 with the power line voltage set at 115/230 volts.

TABLE 4-5. REGULATED POWER SUPPLY TOLERANCES

Nominal Voltage	Nominal Ripple at 115/230 vrms Input	Output Voltage Range
-200 (violet wire)	10 mv	200 ±8 volts
+300 (red wire)	10 mv	300 ±12 volts
+27 (brown-orange wire)	---	unregulated

4-12 AUDIO OSCILLATOR

Set RANGE - - - - - - - - - 540 KC-1800 KC
MODULATION SELECTOR - - - - INT 400 ∿

1) Turn POWER switch to ON.

2) Connect an hp 400D AC VTVM to output tap on audio transformer (yellow lead on single tie point behind rf output meter). Connect ground lead of voltmeter to ground.

3) Set Mod. Osc. Adj (R51) potentiometer for 3.2 volts. This control is the middle one in the row of five potentiometers on top of the modulation deck.

4-13 CRYSTAL CALIBRATOR

Set XTAL CALIBRATOR - - - - - - - - 100 KC

1) Connect an electronic counter to pin 2 of the Crystal Oscillator tube (V10).

2) Adjust trimmer (C41) for exactly 100.000 KC. This trimmer is the ceramic capacitor on the right side (as viewed from the front) of the instrument under the modulation deck.

3) Set XTAL CALIBRATOR to 1 MC and read counter. Reading should be between 999.900 to 1000.100 KC.

4) Set XTAL CALIBRATOR to 100 KC and read counter. Reading should be between 99.990 to 100.010 KC.

5) Set trimmer C41 to best compromise between the above limits.

6) Turn XTAL CALIBRATOR to OFF.

4-14 TUNE OSCILLATOR AND AMPLIFIER

NOTE

This procedure should be performed only if there is a definite indication that the oscillator is off frequency. It should NOT be done on a routine basis.

Set CALIBRATE cursor to align with FREQUENCY centerline
ATTENUATOR - - - - - - - - - - - .3 VOLT
MODULATION SELECTOR - - - - - - - CW
FREQUENCY dial - - - - - low end of one of the bands (except highest frequency)

1) Connect RF OUT terminal to an electronic counter, such as the hp Model 524B/C/D with a Model 525A Converter.

2) If the frequency as read on the FREQUENCY dial is off more than 1%, adjust the slug in the oscillator coil to correct. This slug can be reached by removing the cabinet (see paragraph 4-2) and removing the plug button in the rf shield (on left side of instrument when viewed from the front). Rotate the turret to put the coil in position so that the tuning screw can be reached. After adjustment rotate the turret to put the coil back in operation to recheck. Clockwise rotation of the slug will decrease the frequency.

3) Shift the frequency to the high end of the band. If the frequency as read on the FREQUENCY dial is off more than 1% adjust the trimmer capacitor (C7) across the oscillator coil to correct. This adjustment can be made through the same hole in the rf shield as in step 2 without having to move the turret. Always use a plastic screwdriver when making this adjustment.

4) Repeat steps 2 and 3 until no further adjustment is necessary.

5) Repeat steps 1 through 4 on the other bands. On the highest frequency band adjust the slug with a plastic allen wrench (#8).

If any adjustment is necessary check maximum oscillator current as in paragraph 4-15.

6) Connect the probe of an oscilloscope to the cathode of CR3. This point can be found on the pink-white wire between the amplifier stator turret terminal block and the tie-point for the 33K resistor R25.

7) Set the MODULATION SELECTOR to EXT. DC.

8) Connect a square-wave generator, such as the hp Model 211A set to 1 KC to the MODULATION INPUT-OUTPUT connector. Feed in sufficient square-wave signal so that the carrier is cut-off for at least part of the cycle.

9) Tune throughout all bands and check the pattern on the oscilloscope for ringing or squegging. Reduce the frequency of the external modulation to 300 cps on the lowest frequency band to keep from overmodulating. If ringing is found, remove the shield to retune the amplifier. See paragraph 4-2 for instructions to remove this shield.

10) Measure the RF Amplifier plate current with hp Model 428A Clip-On Milliammeter clipped over the red-green lead going to the 100 ohm resistor R15 on the turret stator contact terminal block (beneath RF Amplifier chassis). If a Model 428A is not available, unsolder the red-green lead on the B+ side and insert a conventional 300 ma milliammeter. By-pass the point between the 100 ohm resistor and the meter with a 0.1 mfd capacitor.

11) Tune the inner slug in the amplifier coil from the top for a plate current dip at the low end of one band.

12) Tune the trimmer capacitor for a plate current dip at the high end of the same band. This adjustment is made through a hole in the chassis between V3 and V4 underneath the amplifier turret shaft. Use a plastic screwdriver for this adjustment. In addition, if this tool has a metal tip, slide a tiny piece of tubing over the metal tip to prevent the trimmer shorting to ground when making this adjustment.

13) Recheck ringing as in step 9.

14) Repeat steps 9-13 on all bands.

4-15 SET MAXIMUM OSCILLATOR CURRENT

Set MODULATION SELECTOR - - - - - - - CW
RANGE - - - - - - - - - - 19 MC-65 MC

1) Measure RF Oscillator plate current with hp Model 428A Clip-On Milliammeter clipped over red-green lead going to the 100 ohm resistor R9 on turret stator contact terminal block (beneath oscillator chassis). If a Model 428A is not available, unsolder the red-green lead on the B+ side and insert a conventional 300 ma milliammeter. By-pass the point between the 100 ohm resistor and the meter with a 0.1 mfd capacitor.

2) Tune FREQUENCY dial throughout the 19 MC-65 MC band while noting the current.

3) Adjust Osc. Level control (R3) on the oscillator chassis for a maximum current of 25 ma at the frequency of maximum current.

If this adjustment is made, check the following:

- Paragraph 4-16, Carrier Zero Set
- Paragraph 4-17, Maximum Carrier Set and Modulation Zero Set
- Paragraph 4-18, Set Percentage Modulation Meter

4-16 CARRIER ZERO SET

Set RANGE - - - - - - - - - - 50 KC - 170 KC
ATTENUATOR - - - - - - - - - - 1 VOLT
ATTENUATION VERNIER - - - - - fully ccw
Carrier Output Zero (R35) - - - - fully ccw
MOD. SELECTOR - - - EXT DC with no input
MODULATION VERNIER - - - - - fully ccw

1) Connect oscilloscope to output of the Output Termination.

2) Zero-Set the carrier output meter with the instrument off as explained in paragraph 4-9.

3) Turn on and allow 5 minutes warm-up.

4) Slowly turn Carrier Zero Set control (R35) on the RF Amplifier chassis clockwise until there is some output on the oscilloscope. Then adjust Carrier Zero Set until the indication on the oscilloscope, set to the most sensitive range, just collapses. Set the sweep on the oscilloscope for a free-running condition so that the indication will not disappear for lack of synchronizing signal.

5) Check for zero output across the band on each range. Bands 5.8 MC-19.2 MC and 19.2 MC-65 MC typically have a minimum output of .03 vrms.

If this adjustment is made, check the following:

- Paragraph 4-17, Maximum Carrier Set and Modulation Zero Set
- Paragraph 4-18, Set Percentage Modulation Meter

4-17 MAXIMUM CARRIER SET AND MODULATION ZERO SET

Set ATTENUATOR VERNIER pot. - - - fully cw
MODULATION SELECTOR - - - - - EXT AC

1) Connect Model 410B AC probe to end of Output Termination. Solder tip of 410B AC probe to center conductor of a UG-290/U connector. Clip ground end of probe to skirt of connector. Insert connector into OUTPUT connector of Output Termination.

2) Set RANGE switch to band 1 (see box on schematic for band frequency ranges) and turn FREQUENCY dial over the band at moderate speed, noting the minimum output voltage read on the 410B.

3) Repeat step 2 on bands 2, 3, 4, 5; and repeat on band 6 but turn much more slowly.

4) Set 606A to the range and frequency having lowest output voltage. Set MODULATION SELECTOR switch to CW, adjust Max. Carrier Set (R60) for 1.05 v rf output on 410B. This control is fourth from the front in the row of five potentiometers on the top of the modulation deck.

5) Switch MODULATION SELECTOR from CW to EXT AC while noting output change on the 410B. There should be no change in voltage shown on the 410B. If necessary adjust Mod. Zero Set (R69, rearmost control in row of five controls on modulation chassis) until there is no change of output when the MODULATION SELECTOR is switched. Turn the MODULATION AMPLITUDE control. The output should not change. If necessary, adjust R69.

6) Recheck step 4 and step 5 and adjust, if necessary. The two controls R69 and R60 interact with each other. Recheck the other adjustment any time one control is adjusted.

4-18 SET PERCENT MODULATION METER

Set FREQUENCY - - - - - - - - - - - - - 1 MC
MODULATION SELECTOR - - - INT 1000 ∿
ATTENUATOR - - - - - - - - 1 VOLT range
VERNIER - - - - - - - - - - - - - 1 volt
meter mechanical zero as described in par. 4-9
PERCENTAGE MODULATION meter
MODULATION AMPLITUDE - - - - 50% on

1) Connect the RF OUT output, properly terminated, to the vertical input terminals of an oscilloscope such as an ℌ Model 150A. If a lower frequency oscilloscope is used it may be necessary to set the Model 606A to a lower frequency.

2) Synchronize the pattern internally so that several modulation cycles are visible on the screen.

3) Switch the MODULATION SELECTOR to CW.

4) Adjust the sensitivity control on the oscilloscope until the pattern is exactly 4 centimeters high. Do not use the 3 VOLTS range on the Model 606A.

5) Switch the MODULATION SELECTOR to INT 1000 ∿.

6) Set PERCENTAGE MODULATION meter to 50% with the MODULATION AMPLITUDE control. The pattern on the screen should now be six centimeters high at the peaks and two centimeters high at the troughs (see Figure 4-2). If pattern is not exactly three times as high at the peaks as at the troughs, adjust the MODULATION AMPLITUDE control until it is. The Model 606A is now modulating exactly 50%.

7) Adjust Mod. Cal.(R67) control until PERCENTAGE MODULATION Meter reads 50%. This control is second from the front in the row of five controls on the modulation chassis.

8) Set ATTENUATOR VERNIER to 0.2 VOLTS.

9) Repeat steps 3-6. If the reading on the PERCENTAGE MODULATION meter is not 50 ±5% adjust MODULATION AMPLITUDE until it is. Now adjust Carrier Zero Set (R35) slightly until the pattern on the oscilloscope is as in step 6. Recheck MAXIMUM CARRIER SET paragraph 4-17 resetting R60, if necessary.

4-19 CALIBRATE RF OUTPUT METER

Set MODULATION SELECTOR - - - - - - - CW
ATTENUATOR - - - - - - - - 1 VOLT range

1) Connect AC Probe of Model 410B High Frequency VTVM (1 volt range) to the end of the Output Termination. Solder tip of 410B ac probe connector of a UG-290/U connector. Clip ground lead of probe to skirt of connector. Insert connector into OUTPUT connector of Output Termination.

2) Set ATTENUATOR VERNIER for 0.9 vrms out.

3) Rotate the FREQUENCY dial and RANGE switch through all frequencies while observing the output on the 410B and keeping the reading on the output meter at 0.9 volts. Record the lowest and highest output.

4) Set the FREQUENCY dial to the frequency of the highest output and the ATTENUATOR VERNIER to 0.9 volt.

5) Add one-half of the difference between the readings in step 3 to 0.9 volt.

6) Check the output meter zero adjustment (see paragraph 4-2.

7) Set the Model 410B to the reading obtained in step 5 by adjusting the ATTENUATOR VERNIER.

8) Set the output meter to read 0.9 volt by adjusting Output Cal. control (R73).

4-20 ADJUST FEEDBACK RELAY

Set ATTENUATOR to 3 VOLTS. Feedback relay K1 should operate, increasing the output to 3 volts. If the relay does not operate, complete the following procedure.

1) Clip an hp Model 428A Clip-On Milliammeter over the lead going to the coil of relay, K1. If a Model 428A is not available, unsolder the lead and insert a conventional 10 ma milliammeter.

2) Set ATTENUATOR to 3 VOLTS range. The current through the relay should be a nominal 5.5 ma. If the current is not at least this value, check the +300 volts supply and C26, C27, R27, R28 and R46. If this current does not operate the relay, fix or replace the relay. If the relay operates but the output does not increase to 3 volts, check R25, R26 and the entire feedback loop.

SCHEMATIC DIAGRAM NOTES

1. Heavy solid line shows main signal path; heavy dashed line shows control, secondary signal, or feedback path.
2. Heavy box indicates front-panel engraving.
3. Arrows on potentiometers indicate clockwise rotation as viewed from the round shaft end, counterclockwise from the rectangular shaft end.
4. Resistance values in ohms, inductance in microhenries, and capacitance in micromicrofarads unless otherwise specified.
5. Rotary switch schematics are electrical representations; for exact switching details refer to the switch assembly drawings.
6. Relays shown in condition prevailing during normal instrument operation.
7. ‡ indicates a selected part. See parts list.
8. Interconnecting parts and assemblies are shown on cable diagram.
9. * indicates factory adjustment. Part may be omitted.

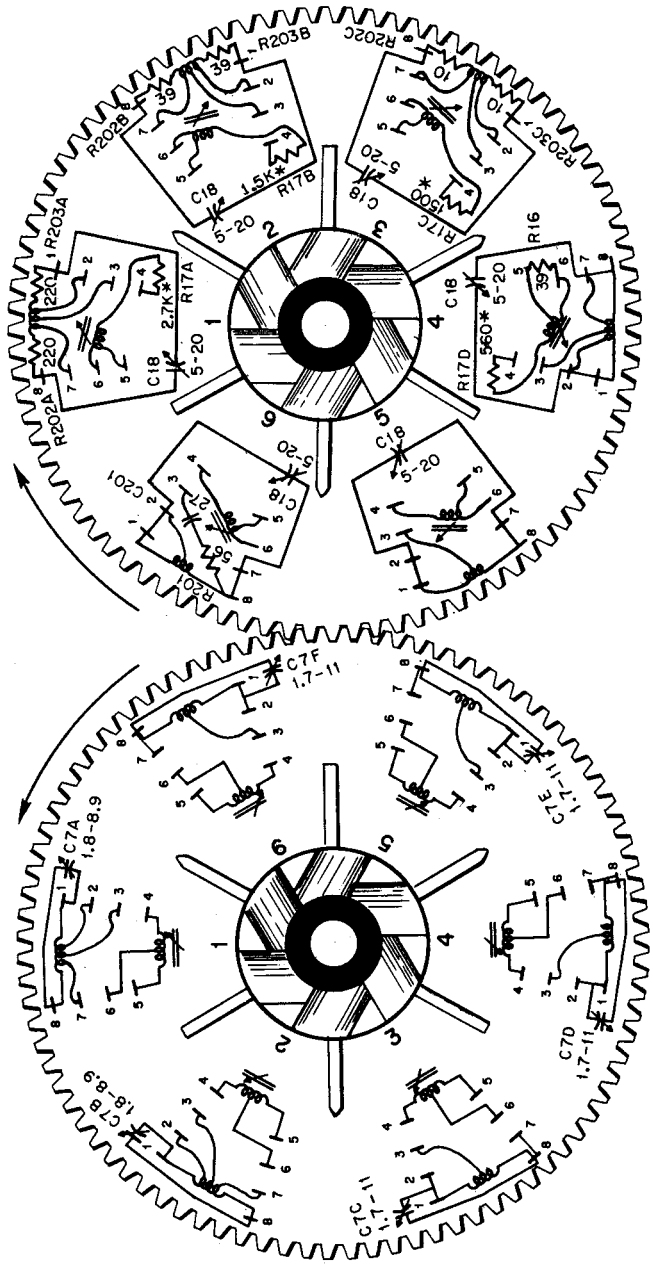


Figure 4-6. Turret Schematic

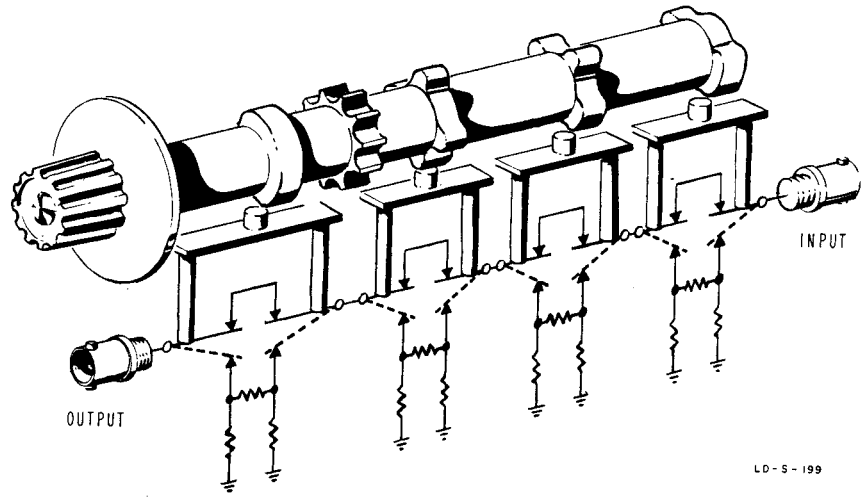


Figure 4-9. Attenuator

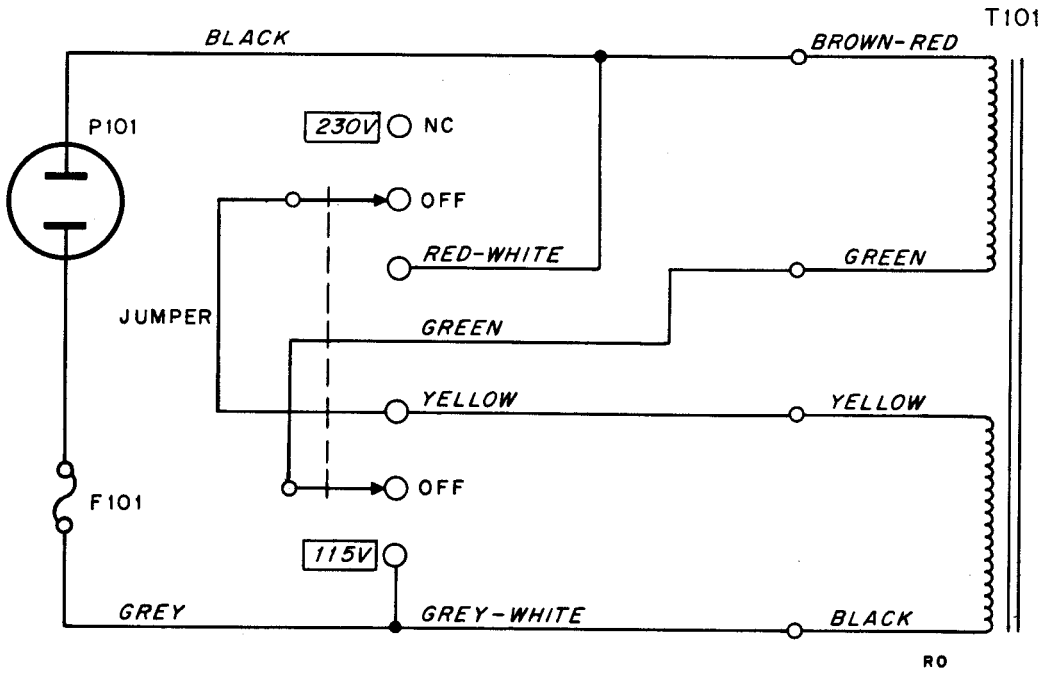
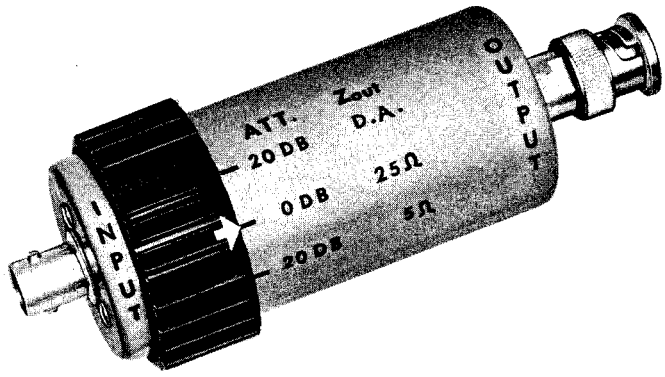


Figure 4-10. 115/230 Volt Power Switch



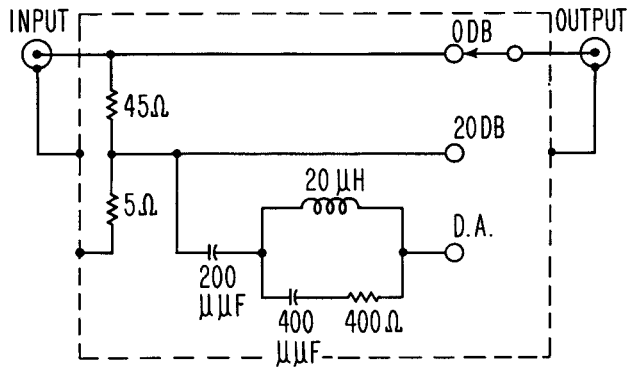


Figure 4-11. Output Termination

SECTION V
TABLE OF REPLACEABLE PARTS

NOTE

Standard components have been used in this instrument, whenever possible. Special components may be obtained from your local Hewlett-Packard representative or from the factory.

When ordering parts always include:

1. ℌ Stock Number.
2. Complete description of part including circuit reference.
3. Model number and serial number of instrument.
4. If part is not listed, give complete description, function and location of part.

Corrections to the Table of Replaceable Parts are listed on an Instruction Manual Change sheet at the front of this manual.

RECOMMENDED SPARE PARTS LIST

Column RS in the Table lists the recommended spare parts quantities to maintain one instrument for one year of isolated service. Order complete spare parts kits from the Factory Parts Sales Department. ALWAYS MENTION THE MODEL AND SERIAL NUMBERS OF INSTRUMENTS INVOLVED.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
C1 thru C3	Capacitor: fixed, ceramic, .01 μf ±20%, 250 vdcw CW*	15-135	9	2		
C4, 5	Capacitor: variable, air, 2 section, 9.5-442.2 pf W*	12-40	2	1		
C6	Same as C1					
C7 A, B	Capacitor: variable air, 1.8-8.9 pf (bands 1, 2) AO*	12-45	2	1	Used one at a time but changes with band used	
C7 C, D, E	Capacitor: variable, air, 1.7-11 pf (bands 3, 4, 5, 6) AO*	12-44	4	1		
C8	Capacitor: fixed, mylar, .1 μf ±20%, 600 vdcw Texas Capacitor Co.	16-110	13	3		
C9	Capacitor: fixed, ceramic, 2 pf ±1 pf 500 vdcw N1400 L*	15-86	1	1		
C10A, B, C	Capacitor: fixed, electrolytic, 3 sections, 10 μf/sect., 450 vdcw X*	18-31	1	1		
C11	Same as C8					
C12	Capacitor: variable, polystyrene, 0.7-3.0 pf L*	13-30	1	1		
C13	Capacitor: fixed, mica, 100 pf ±10%, 300 vdcw V*	14-73	1	1		
C14, 15	Capacitor: variable, air, two section, 9.5-442.2 pf W*	12-39	2	1		
C16	Capacitor: fixed, ceramic, .01 μf -0% +100%, 1000 vdcw CC*	15-43	2	1		
C17	Capacitor: fixed, ceramic, 14 pf ±3%, 500 vdcw L*	15-171	1	1		
C18	Capacitor: variable, ceramic, 5-20 pf , 500 vdcw L*	13-20	1	1		
C19	Capacitor: fixed, mica, 22 pf ±5%, 500 vdcw V*	14-69	1	1		
C20	Capacitor: fixed, mica, 2200 pf ±10%, 500 vdcw Z*	14-52	1	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

TQ - Total quantity used in the instrument.

RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
C21	Capacitor: fixed, mica, 1000 pf ±5%, 500 vdcw A*	15-57	1	1		
C22	Capacitor: fixed, mica, 10,000 pf ±10%, 300 vdcw V*	14-23	1	1		
C23	Capacitor: fixed, mica, 180 pf ±10%, 500 vdcw Z*	14-51	1	1		
C24	Capacitor: fixed, mica, 470 pf ±10%, 500 vdcw V*	14-62	1	1		
C25	Capacitor: fixed, mica, 82 pf ±5%, 500 vdcw J*	15-115	1	1		
C26	Same as C1					
C27	Same as C8					
C28, 29	Same as C1					
C30 thru C33	Same as C8					
C34 thru C36	These circuit references not assigned					
C37, 38	Same as C8					
C39	Capacitor: fixed, mica, 3300 pf ±10%, 500 vdcw V*	14-64	1	1		
C40	Capacitor: fixed, mica, 68 pf ±5%, 500 vdcw Z*	15-75	1	1		
C41	Capacitor: variable, ceramic, 5-20 pf , 500 vdcw L*	13-20	1	1		
C42	This circuit reference not assigned					
C43	Capacitor: fixed, ceramic, .005 μf, 500 vdcw K*	15-47	2	1		
C44	Capacitor: fixed, ceramic, 0.05 μf ±20%, 400 vdcw NN*	15-161	1	1		
C45	Same as C43					
C46	Same as C8					

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
C47	Capacitor: fixed, ceramic, .02 μf -0% +100%, 600 vdcw Radio Materials Co.	15-85	1	1		
C48	Same as C1					
C49	Capacitor: fixed, paper, .0033 μf ±10%, 600 vdcw CC*	16-23	1	1		
C50, 51	Capacitor: fixed, mica, .0056 μf ±1%, 300 vdcw K*	15-42	2	1		
C52	Capacitor: fixed, mylar, 1 μf ±5%, 200 vdcw CW*	16-102	1	1		
C53	Capacitor: fixed, ceramic, 1000 pf ±25%, 500 vdcw K*	15-21	1	1		
C54	Same as C8					
C55	Capacitor: fixed, mica, 1000 pf ±10%, 500 vdcw V*	14-11	1	1		
C56	Capacitor: fixed, electrolytic, 20 μf, 25 vdcw CC*	18-66	1	1		
C57 thru C100	These circuit references not assigned					
C101, 102	Capacitor: fixed, electrolytic, 2 sections, 120 x 4μf, 400 vdcw CC*	18-51HP	4	1		
C103	Same as C16					
C104, 105	Same as C101					
C106	Same as C8					
C107	Same as C1					
C108	Same as C101					
C109, 110	Same as C8					
C111	Capacitor: fixed, electrolytic, 1 section, 500 μf, 75 vdcw CC*	18-68HP	1	1		
C112, 113	Capacitor: fixed, paper, 0.1 μf ±10%, 600 vdcw CC*	16-1	2	1		
C114, 115	Capacitor: fixed, ceramic, 1000 pf ±20%, 500 vdcw L*	15-68	2	1		

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		℗ STOCK NO.	TQ	RS		
C116 thru C200	These circuit references not assigned						
C201	Capacitor: fixed, mica, 27 pf ±5%, 500 vdcw	Z*	14-78	1	1		
CR1 thru CR3	Diode, crystal:	BU*	212-G11A	3	3		
CR4 thru CR6	Diode, germanium: 75 V PIV 5 ma max	BU*	212-1N90	3	3		
CR7 thru CR100	These circuit references not assigned						
CR101 thru CR108	Rectifier, silicon: 400 V PIV, 500 ma	BV*	212-147	8	8		
CR109 thru CR112	Rectifier, silicon: 100 V PIV, 500 ma	BV*	212-148	4	4		
DS1 thru DS100	These circuit references not assigned						
DS101	Lamp, incandescent: 6-8V, .15 Amp	O*	211-47	1	1		
F1	Fuse, cartridge: .15 Amp	T*	211-54	1	10		
F2 thru F100	These circuit references not assigned						
F101	Fuse, cartridge: 2 Amp, 125 V	E*	211-16	1	10		
J1	Jack, telephone	KK*	124-11	1	1		
J2	Connector: BNC	LL*	125-145	1	1		
J3	Connector: BNC, MODULATION	LL*	125-9	1	1		
J4 thru J100	These circuit references not assigned						

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
J101	Connector, power: 15 Amp, 125 vrms, 7.5 Amp 220 V Kulka	125-136	1	1		
K1	Relay, armature: SPDT, 2 Amp, 125 V CT*	49-34	1	1		
L1	Coil, R.F.: 33 μh Western Coil Co.	48-95	4	1		
L2	This circuit reference not assigned					
L3, 4	Same as L1					
L5	Coil: 400 μh ±5% Western Coil Co.	48-94	4	1		
L6	Same as L1					
L7 thru L101	These circuit references not assigned					
L102 thru L104	Same as L5					
M1	Meter - MODULATION HP*	112-96	1	1		
M2	Meter, output HP*	112-95	1	1		
P1 thru P100	These circuit references not assigned					
P101	Cable, power: 3 wire #18 Zip-cord w/NEMA 3-prong plug, 2' long Cords Ltd	812-101	1	1		
P102	Cord, power: 6' long Elec. Cord Co.	812-56	1	1		
R1	Resistor: fixed, composition, 390,000 ohms ±10%, 1 W B*	24-390K	1	1		
R2	Resistor: fixed, composition, 150,000 ohms ±10%, 1 W B*	24-150K	1	1		
R3	Resistor: variable, composition, 50,000 ohms ±20%, 1/4 W, linear taper BO*	210-189	4	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

TQ - Total quantity used in the instrument.

RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		ℌ STOCK NO.	TQ	RS		
R4, 5	Resistor: fixed, composition, 47,000 ohms ±10%, 1/2 W	B*	23-47K	4	1		
R6	Resistor: fixed, composition, 100,000 ohms ±10%, 1/2 W	B*	23-100K	5	2		
R7, 8	Resistor: fixed, composition, 270 ohms ±10%, 1/2 W	B*	23-270	2	1		
R9	Resistor: fixed, wirewound, 100 ohms ±10%, 5 W	B*	26-131	2	1		
R10	Resistor: fixed, composition, 33,000 ohms ±10%, 2 W	B*	25-33K	4	1		
R11,12	Resistor: fixed, composition, 220 ohms ±10%, 1/2 W	B*	23-220	2	1		
R13,14	Resistor: fixed, composition, 39 ohms ±10%, 1/2 W	B*	23-39	7	2		
R15	Same as R9						
R16	Same as R13, Optimum value selected at factory. Average value shown						
R17A	Resistor: fixed, composition, 2,700 ohms ±10%, 1/2 W Optimum value selected at factory. Average value shown.	B*	23-2.7K	1	1		
R17B, 17C	Resistor: fixed, composition, 1,500 ohms ±10%, 1/2 W Optimum value selected at factory. Average value shown.	B*	23-1.5K	2	1		
R17D	Resistor: fixed, composition, 560 ohms ±10%, 1/2 W Optimum value selected at factory. Average value shown.	B*	23-560	1	1		
R18	Resistor: fixed, deposited carbon, 50 ohms ±1%, 1/2 W	NN*	33-50R	1	1		
R19	Resistor: fixed, composition, 33,000 ohms ±10%, 1 W (pin 1 of V1)	B*	23-33K	1	1		
R20	Same as R10						
R21	Resistor: fixed, composition, 330,000 ohms ±10%, 1/2 W	B*	23-330K	2	1		
R22	Resistor: fixed, composition, 1000 ohms ± 5%, 1/2 W	B*	23-1000-5	1	1		
R23	Resistor: fixed, composition, 1600 ohms ±5%, 1/2 W	B*	23-1600-5	1	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**

TQ - **Total quantity used in the instrument.**

RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
R24	Resistor: fixed, composition, 220,000 ohms ±10%, 1/2 W B*	23-220K	2	1		
R25	Resistor: fixed, deposited carbon, 33,000 ohms ±1%, 1 W NN*	31-33K	1	1		
R26	Resistor: fixed, deposited carbon, 6750 ohms ±1%, 1/2 W NN*	33-6750	1	1		
R27, 28	Resistor: fixed, composition, 27,000 ohms ±10%, 2 W B*	25-27K	2	1		
R29	Resistor: fixed, composition, 120,000 ohms ±10%, 1 W B*	24-120K	2	1		
R30	Resistor: fixed, composition, 220,000 ohms ±10%, 1 W B*	24-220K	1	1		
R31	Same as R9					
R32	Resistor: fixed, wirewound, 20,000 ohms ±10%, 10 W S*	26-77	1	1		
R33	Resistor: fixed, composition, 330,000 ohms ±10%, 1 W B*	24-330K	1	1		
R34	Same as R29					
R35	Resistor: variable, composition, 200,000 ohms BO*	210-22	1	1		
R36	Resistor: fixed, deposited carbon, 25,500 ohms ±1%, 1/2 W NN*	33-25.5K	1	1		
R37	Same as R3					
R38	Same as R10					
R39	Same as R24					
R40	Resistor: fixed, composition, 1 megohm ±10%, 1/2 W B*	23-1M	1	1		
R41	Resistor: fixed, composition, 22,000 ohms ±10%, 1/2 W B*	23-22K	1	1		
R42	Same as R6					
R43	Resistor: fixed, composition, 2.2 megohms ±10%, 1/2 W B*	23-2.2M	1	1		

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
R44	Resistor: fixed, composition, 470,000 ohms ±10%, 1/2 W B*	23-470K	1	1		
R45	Same as R10					
R46	Resistor: fixed, composition, 1000 ohms ±10%, 1/2 W B*	23-1000	1	1		
R47	Resistor: fixed, composition, 680 ohms ±10%, 1/2 W B*	23-680	6	2		
R48	Resistor: fixed, composition, 150,000 ohms ±10%, 1/2 W B*	23-150K	2	1		
R49	Resistor: fixed, composition, 560,000 ohms ±10%, 1/2 W B*	23-560K	1	1		
R50	Resistor: fixed, composition, 56,000 ohms ±10%, 1 W B*	24-56K	1	1		
R51	Resistor: variable, composition, 1000 ohms, linear taper, G*	210-51	1	1		
R52	Resistor: fixed, composition, 2700 ohms ±10%, 1/2 W B*	23-2700	1	1		
R53	Resistor: fixed, composition, 82,000 ohms ±10%, 1/2 W B*	23-82K	1	1		
R54	Part of S6					
R55	Resistor: fixed, deposited carbon, 75,000 ohms ±1%, 1 W NN*	31-75K	1	1		
R56	Resistor: fixed, deposited carbon, 28,400 ohms ±1%, 1/2 W NN*	33-28.4K	2	1		
R57	Resistor: fixed, deposited carbon, 680 ohms ±1%, 1/2 W NN*	33-680	1	1		
R58	Resistor: fixed, deposited carbon, 71,560 ohms ±1%, 1/2 W NN*	33-71.56K	1	1		
R59	Same as R56					
R60	Resistor: variable, wirewound, 15,000 ohms ±10%, 2 W BO*	210-185	2	1		
R61	Resistor: fixed, metal film, 20,000 ohms ±10%, 4 W AB*	334-20K	1	1		
R62	Resistor: fixed, metal film, 24,000 ohms ±10%, 4W AB*	334-24K	1	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		℗ STOCK NO.	TQ	RS		
R63	Resistor: variable, wirewound, 5,000 ohms ±10%, 2 W	I*	210-282	1	1		
R64	Resistor: fixed, wirewound, 30,000 ohms ±5%, 10 W	S*	26-12	1	1		
R65	Same as R4						
R66	Resistor: fixed, composition, 47,000 ohms ±10%, 2 W	B*	25-47K	1	1		
R67	Same as R3						
R68	Resistor: fixed, metal film, 30,000 ohms ±10%, 4 W	AB*	334-30K	1	1		
R69	Same as R60						
R70	This circuit reference not assigned						
R71	Same as R21						
R72 thru R100	These circuit references not assigned						
R101	Resistor: fixed, wirewound, 5 ohms ±10%, 5 W	AS*	26-103	1	1		
R102	Resistor: fixed, composition, 820,000 ohms ±10%, 1/2 W	B*	23-820K	1	1		
R103	Same as R47						
R104	Resistor: fixed, composition, 10 megohms ±10%, 1/2 W	B*	23-10M	1	1		
R105	Resistor: fixed, composition, 1.2 megohms ±10%, 1/2 W	B*	23-1.2 M	1	1		
R106	Resistor: fixed, composition, 33 ohms ±10%, 1/2 W	B*	23-33	5	2		
R107	Resistor: fixed, composition, 8.2 megohms ±10%, 1/2 W	B*	23-8.2M	1	1		
R108	Same as R6						
R109	Same as R47						
R110	Resistor: fixed, deposited carbon, 600,000 ohms ±1%, 1/2 W	NN*	33-600K	1	1		

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
R111	Resistor: fixed, deposited carbon, 405,000 ohms ±1%, 1/2 W NN*	33-405K	2	1		
R112	Same as R106					
R113	Resistor: fixed, composition, 56,000 ohms ±10%, 2 W B*	25-56K	1	1		
R114	Same as R47					
R115	Same as R106					
R116	Same as R47					
R117	Same as R106					
R118	Same as R47					
R119	Same as R106					
R120	Resistor: fixed, wirewound, 10,000 ohms ±10%, 10 W S*	26-10	1	1		
R121	Resistor: fixed, composition, 68,000 ohms ±10%, 1/2 W B*	23-68K	1	1		
R122	Resistor: fixed, composition, 3.9 megohms ±10%, 1/2 W B*	23-3.9M	1	1		
R123	Resistor: fixed, composition, 56,000 ohms ±10%, 1/2 W B*	23-56K	1	1		
R124	Same as R6					
R125	Same as R111					
R126	Same as R3					
R127	Resistor: fixed, deposited carbon, 284,000 ohms ±1%, 1/2 W NN*	33-284K	1	1		
R128	Resistor: fixed, composition, 18,000 ohms ±10%, 1 W B*	24-18K	1	1		
R129	Resistor: fixed, composition, 1.2 megohms ±10%, 1 W B*	24-1.2M	1	1		
R130	Same as R6					
R131	Same as R4					
R132	Resistor: fixed, composition, 270 ohms ±10%, 1 W B*	24-270	1	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		℗ STOCK NO.	TQ	RS		
R133	Same as R48						
R134	Resistor: fixed, composition, 33,000 ohms ±10%, 1/2 W	B*	23-33K	1	1		
R135	Resistor: fixed, composition, 10 ohms ±10%, 1 W	B*	24-10	1	1		
R136 thru R200	These circuit references not assigned						
R201	Resistor: fixed, composition, 56 ohms ±10%, 1/2 W	B*	23-56	1	1		
R202A, R203A	Resistor: fixed, composition, 220 ohms ±10%, 1 W	B*	24-220	2	1		
R202B, R203B	Same as R13						
R202C, R203C	Resistor: fixed, composition, 10 ohms ±10%, 1/2 W	B*	23-10	2	1		
RT1	Lamp, glow: 250 V, 10 W	O*	211-29	1	1		
S1	Switch, toggle: DPDT	D*	310-197	1	1		
S2	This circuit reference not assigned						
S3	Switch, rotary: 2 sections, 6 pos.	W*	310-262	1	1		
S4	This circuit reference not assigned						
S5	Switch, rotary:		310-254	1	1		
S6	Switch, rotary: 1 section, 5 position, includes R54 - variable,1000 ohms	W*	310-255	1	1		
S7	Switch: SPDT, 125 Vac, 10 Amps	AQ*	310-152	1	1		
S8 thru S100	These circuit references not assigned						
S101	Switch, toggle: SPST, 250 V 3 Amp	CR*	310-11	1	1		

*** See "List of Manufacturers Code Letters For Replaceable Parts Table".**
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION		℗ STOCK NO.	TQ	RS		
T1	Transformer, Audio	HP*	912-61	1	1		
T2 thru T100	These circuit references not assigned						
T101	Transformer, power	HP*	910-173	1	1		
V1	Tube, electron:	EE*	212-6AW8A	4	4		
V2	Tube, electron: 12AT7	O*	212-12AT7	4	4		
V3, 4	Tube, electron: 6CL6	O*	212-6CL6	2	2		
V5	Same as V2						
V6	Tube, electron: 12B4A	O*	212-12B4A	7	7		
V7	Same as V2						
V8	Same as V1						
V9	Same as V2						
V10	Same as V1						
V11 thru V100	These circuit references not assigned						
V101 thru V105	Same as V6						
V106	Same as V1						
V107	Same as V6						
V108	Same as V1						
V109	Tube, electron: 5651	Y*	212-5651	1	1		
XTAL1	Crystal unit: Quartz, 1000 kc	Midland Crystal	41-40	1	1		
XTAL2	Crystal unit: Quartz, 100 kc	Midland Crystal	41-41	1	1		

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
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TABLE OF REPLACEABLE PARTS

CIRCUIT REF.	DESCRIPTION, MFR. * & MFR. DESIGNATION	℗ STOCK NO.	TQ	RS		
	ACCESSORIES					
	Output Termination HP*	606A-34A	1	1		
	MISCELLANEOUS					
	Attenuator assembly HP*	606A-34B	1	1		
	Holder, fuse: extractor post type T*	140-16	2	1		
	Jewel, pilot light: "POWER" AD*	145-23A	1	1		
	Knob, bar w/skirt: "RANGE" HP*	G-74P	1	1		
	Knob, concentric: "MODULATION SELECTOR" and "ATTENUATOR" HP*	G-74Q	2	1		
	Knob: "FREQUENCY" HP*	G-74BB	1	1		
	Knob: "CALIBRATE" HP*	G-74BZ	1	1		
	Knob: "ATTENUATOR" and "MODULATION AMPLITUDE" HP*	G-74AV	2	1		
	Line filter assembly HP*	606A-27A	1	1		
	Spring, ground on line filter HP*	606A-91A	1	1		

* See "List of Manufacturers Code Letters For Replaceable Parts Table".
TQ - Total quantity used in the instrument.
RS - Recommended spares for one year isolated service for one instrument.

LIST OF CODE LETTERS USED IN TABLE OF REPLACEABLE PARTS TO DESIGNATE THE MANUFACTURERS

CODE LETTER	MANUFACTURER	ADDRESS
A	Aerovox Corp.	New Bedford, Mass.
B	Allen-Bradley Co.	Milwaukee 4, Wis.
C	Amperite Co.	New York, N. Y.
D	Arrow, Hart & Hegeman	Hartford, Conn.
E	Bussman Manufacturing Co.	St. Louis, Mo.
F	Carborundum Co.	Niagara Falls, N. Y.
G	Centralab	Milwaukee 1, Wis.
H	Cinch-Jones Mfg. Co.	Chicago 24, Ill.
HP	Hewlett-Packard Co.	Palo Alto, Calif.
I	Clarostat Mfg. Co.	Dover, N. H.
J	Cornell Dubilier Elec. Co.	South Plainfield, N. J.
K	Hi-Q Division of Aerovox	Olean, N. Y.
L	Erie Resistor Corp.	Erie 6, Pa.
M	Fed. Telephone & Radio Corp.	Clifton, N. J.
N	General Electric Co.	Schenectady 5, N. Y.
O	General Electric Supply Corp.	San Francisco, Calif.
P	Girard-Hopkins	Oakland, Calif.
Q	Industrial Products Co.	Danbury, Conn.
R	International Resistance Co.	Philadelphia 8, Pa.
S	Lectrohm Inc.	Chicago 20, Ill.
T	Littlefuse Inc.	Des Plaines, Ill.
U	Maguire Industries Inc.	Greenwich, Conn.
V	Micamold Radio Corp.	Brooklyn 37, N. Y.
W	Oak Manufacturing Co.	Chicago 10, Ill.
X	P. R. Mallory Co., Inc.	Indianapolis, Ind.
Y	Radio Corp. of America	Harrison, N. J.
Z	Sangamo Electric Co.	Marion, Ill.
AA	Sarkes Tarzian	Bloomington, Ind.
BB	Signal Indicator Co.	Brooklyn 37, N. Y.
CC	Sprague Electric Co.	North Adams, Mass.
DD	Stackpole Carbon Co.	St. Marys, Pa.
EE	Sylvania Electric Products Co.	Warren, Pa.
FF	Western Electric Co.	New York 5, N. Y.
GG	Wilkor Products, Inc.	Cleveland, Ohio
HH	Amphenol	Chicago 50, Ill.
II	Dial Light Co. of America	Brooklyn 37, N. Y.
JJ	Leecraft Manufacturing Co.	New York, N. Y.
KK	Switchcraft, Inc.	Chicago 22, Ill.
LL	Gremar Manufacturing Co.	Wakefield, Mass.
MM	Carad Corp.	Redwood City, Calif.
NN	Electra Manufacturing Co.	Kansas City, Mo.
OO	Acro Manufacturing Co.	Columbus 16, Ohio
PP	Alliance Manufacturing Co.	Alliance, Ohio
QQ	Arco Electronics, Inc.	New York 13, N. Y.
RR	Astron Corp.	East Newark, N. J.
SS	Axel Brothers Inc.	Long Island City, N. Y.
TT	Belden Manufacturing Co.	Chicago 44, Ill.
UU	Bird Electronics Corp.	Cleveland 14, Ohio
VV	Barber Colman Co.	Rockford, Ill.
WW	Bud Radio Inc.	Cleveland 3, Ohio
XX	Allen D. Cardwell Mfg. Co.	Plainville, Conn.
YY	Cinema Engineering Co.	Burbank, Calif.
ZZ	Any brand tube meeting RETMA standards.	
AB	Corning Glass Works	Corning, N. Y.
AC	Dale Products, Inc.	Columbus, Neb.
AD	The Drake Mfg. Co.	Chicago 22, Ill.
AE	Elco Corp.	Philadelphia 24, Pa.
AF	Hugh H. Eby Co.	Philadelphia 44, Pa.
AG	Thomas A. Edison, Inc.	West Orange, N. J.
AH	Fansteel Metallurgical Corp.	North Chicago, Ill.
AI	General Ceramics & Steatite Corp.	Keasbey, N. J.
AJ	The Gudeman Co.	Sunnyvale, Calif.
AK	Hammerlund Mfg. Co., Inc.	New York 1, N. Y.
AL	Industrial Condenser Corp.	Chicago 18, Ill.
AM	Insuline Corp. of America	Manchester, N. H.
AN	Jennings Radio Mfg. Corp.	San Jose, Calif.
AO	E. F. Johnson Co.	Waseca, Minn.
AP	Lenz Electric Mfg. Co.	Chicago 47, Ill.
AQ	Micro-Switch	Freeport, Ill.
AR	Mechanical Industries Prod. Co.	Akron 8, Ohio
AS	Model Eng. & Mfg., Inc.	Huntington, Ind.
AT	The Muter Co.	Chicago 5, Ill.
AU	Ohmite Mfg. Co.	Skokie, Ill.
AV	Resistance Products Co.	Harrisburg, Pa.
AW	Radio Condenser Co.	Camden 3, N. J.
AX	Shallcross Manufacturing Co.	Collingdale, Pa.
AY	Solar Manufacturing Co.	Los Angeles 58, Calif.
AZ	Sealectro Corp.	New Rochelle, N. Y.
BA	Spencer Thermostat	Attleboro, Mass.
BC	Stevens Manufacturing Co.	Mansfield, Ohio
BD	Torrington Manufacturing Co.	Van Nuys, Calif.
BE	Vector Electronic Co.	Los Angeles 65, Calif.
BF	Weston Electrical Inst. Corp.	Newark 5, N. J.
BG	Advance Electric & Relay Co.	Burbank, Calif.
BH	E. I. DuPont	San Francisco, Calif.
BI	Electronics Tube Corp.	Philadelphia 18, Pa.
BJ	Aircraft Radio Corp.	Boonton, N. J.
BK	Allied Control Co., Inc.	New York 21, N. Y.
BL	Augat Brothers, Inc.	Attleboro, Mass.
BM	Carter Radio Division	Chicago, Ill.
BN	CBS Hytron Radio & Electric	Danvers, Mass.
BO	Chicago Telephone Supply	Elkhart, Ind.
BP	Henry L. Crowley Co., Inc.	West Orange, N. J.
BQ	Curtiss-Wright Corp.	Carlstadt, N. J.
BR	Allen B. DuMont Labs	Clifton, N. J.
BS	Excel Transformer Co.	Oakland, Calif.
BT	General Radio Co.	Cambridge 39, Mass.
BU	Hughes Aircraft Co.	Culver City, Calif.
BV	International Rectifier Corp.	El Segundo, Calif.
BW	James Knights Co.	Sandwich, Ill.
BX	Mueller Electric Co.	Cleveland, Ohio
BY	Precision Thermometer & Inst. Co.	Philadelphia 30, Pa.
BZ	Radio Essentials Inc.	Mt. Vernon, N. Y.
CA	Raytheon Manufacturing Co.	Newton, Mass.
CB	Tung-Sol Lamp Works, Inc.	Newark 4, N. J.
CD	Varian Associates	Palo Alto. Calif.
CE	Victory Engineering Corp.	Union, N. J.
CF	Weckesser Co.	Chicago 30, Ill.
CG	Wilco Corporation	Indianapolis, Ind.
CH	Winchester Electronics, Inc.	Santa Monica, Calif.
CI	Malco Tool & Die	Los Angeles 42, Calif.
CJ	Oxford Electric Corp.	Chicago 15, Ill.
CK	Camloc-Fastener Corp.	Paramus, N. J.
CL	George K. Garrett	Philadelphia 34, Pa.
CM	Union Switch & Signal	Swissvale, Pa.
CN	Radio Receptor	New York 11, N. Y.
CO	Automatic & Precision Mfg. Co.	Yonkers, N. Y.
CP	Bassick Co.	Bridgeport 2, Conn.
CQ	Birnbach Radio Co.	New York 13, N. Y.
CR	Fischer Specialties	Cincinnati 6, Ohio
CS	Telefunken (c/o MVM, Inc.)	New York, N. Y.
CT	Potter-Brumfield Co.	Princeton, Ind.
CU	Cannon Electric Co.	Los Angeles, Calif.
CV	Dynac, Inc.	Palo Alto, Calif.
CW	Good-All Electric Mfg. Co.	Ogallala, Nebr.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Hewlett-Packard Company warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Klystron tubes as well as other electron tubes, fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

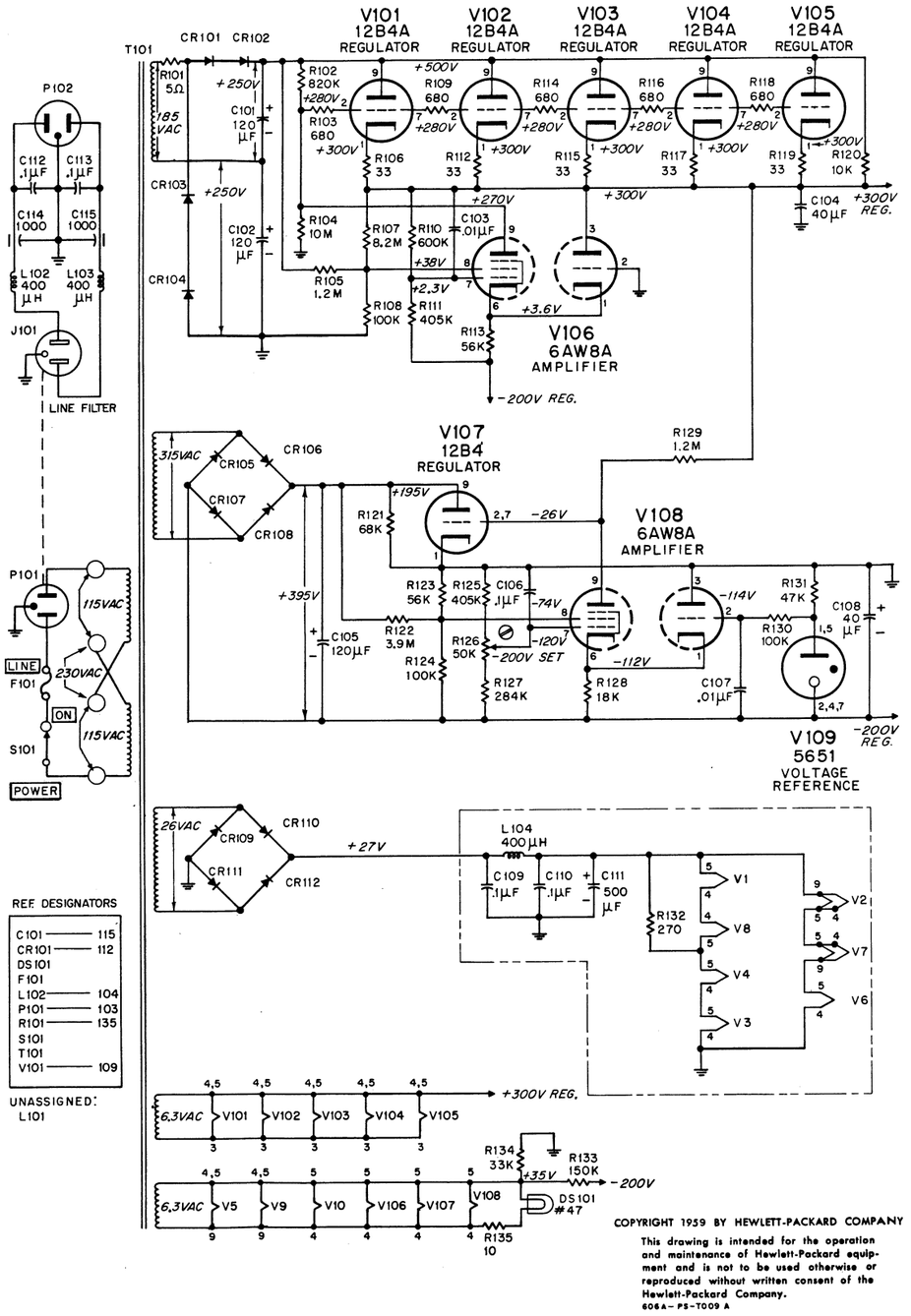
SHIPPING

All shipments of Hewlett-Packard instruments should be made via Truck or Railway Express. The instruments should be packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock-absorbing material.

DO NOT HESITATE TO CALL ON US

HEWLETT-PACKARD COMPANY
Laboratory Instruments for Speed and Accuracy
275 PAGE MILL ROAD PALO ALTO, CALIF. U.S.A.
CABLE "HEWPACK"

FIGURE 4-7
SIGNAL GENERATOR



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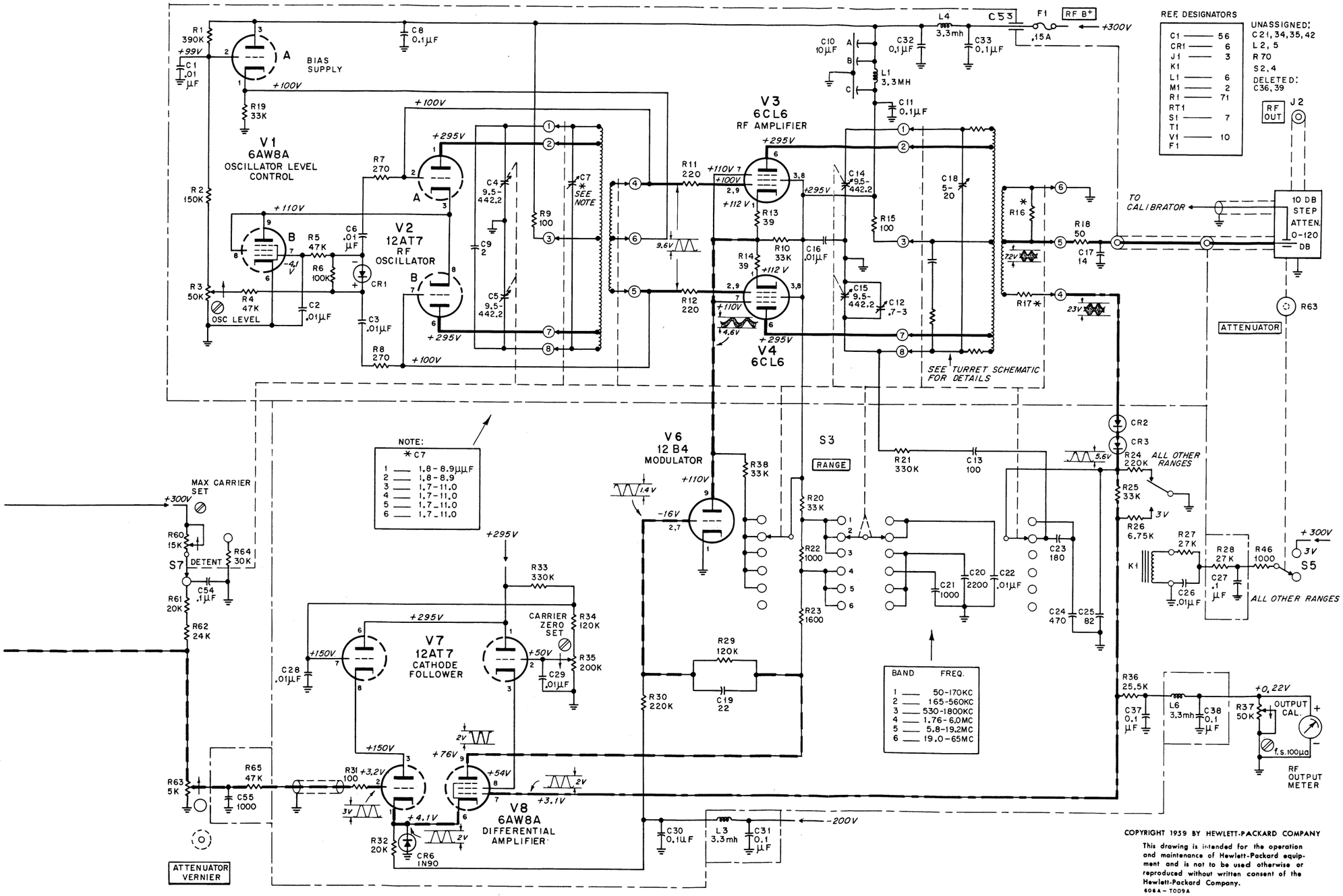
606A-PS-T009 A

Figure 4-8. Power Supply



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